Amelioration or Deterioration?

Basic Pension and Retirement Age under China's New Pension Policy.

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Preface

First of all, I am deeply grateful to my supervisor, Fedor Iskhakov, for his patient help, inspirational suggestions, insightful comments and constant encouragement.

I want to express my profound debt of gratitude to Professor Olav Bjerkholt and Professor Finn Førsund for helping me to Norway for the master studies.

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I also wish to thank all my friends and classmates for making my life in Oslo so enjoyable and memorable.

Lastly and most importantly, I owe a special thank to my dear parents. I love you.

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Abstract

This paper uses a numerical actuarial model to compare pension replacement rates between old and new policies of China. I investigate several cases under different situations, and the results indicate that the new policy is not a Pareto improvement. In most cases, the male retirees benefit from the transition, while female retirees suffer a pension reduction, especially the women working in blue-collar jobs. However, since the replacement level under old policy is not superfluous, in general, the new pension policy should give the retirees at least equal well-being.

In order to find the general way to raise replacement rates, I apply the model for non-continuous employment careers. The calculation which is in line with the existing economic situation in China shows that a suitable plan could be postponing female retirement age step by step while raising accumulation rate in individual pension accounts by 2 or 3 percent points.

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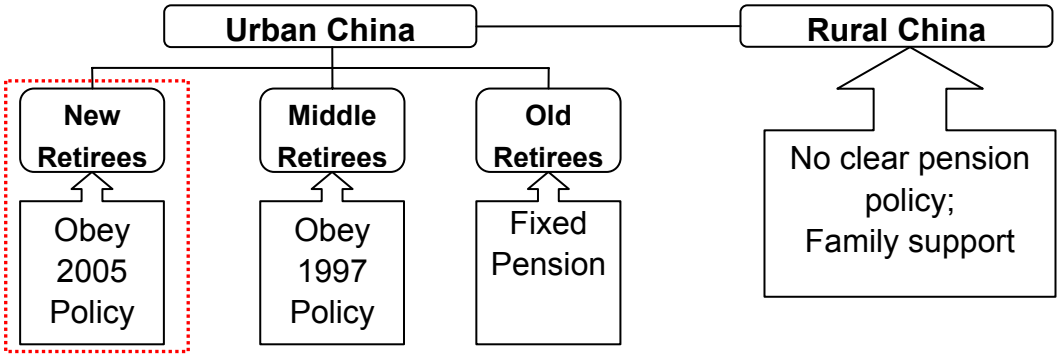
1. Introduction

Pension system is one of the most important parts of social security, which ensures every person can live a suitable life after he/she retires.

In People's Republic of China (China), pension system reform is a very critical issue. Till now, there still hasn't been a clear pension policy in rural China, and most old age persons there are supported by their children. However, for urban workers, due to many years effort, China has established a DC (defined contribution) pension system. This system, which was first defined in 1997, was designed to integrate the PAYG features with individual account, and aimed to be full funded. However, after establishment, idle individual accounts began to exist, and the responsibilities of different departments in 1997 system are not explicit. The system faces important problems both about improving the design and implementation, and about the transition from the old unfunded system to the new arrangements.

In order to improve 1997 pension system, in December 2005, Chinese government promulgated a new policy, which aimed not only to unify the former pension policies which are different among provinces, but also make individual accounts real. (Since this policy changed much from the 1997's, in this thesis, it's considered as "new policy". Correspondingly, the policy which is related to 1997 is called "old policy").

Figure 1: China's Pension System



Currently most articles about China's pension policies or other related pension systems are focusing on the transition from pay-as-you-go system to the funded system, from the macro point of view (Thomas R. Michl and Duncan K. Foley, 2001; John Y. Campbell, 1999). The researchers at the social policy division of the OECD pay lot attentions to China's pension system. Peter Whiteford (2003) and Salditt, F., P. Whiteford and W. Adema (2007) investigated pension reform in China and did some comparisons between China and other countries. However, they used descriptive qualitative analysis other than quantitative analysis. Xiaojun Wang (2001) applied an actuarial model to calculate the pension replacement rates from 2000 to 2050 in China, but he focused on actuarial evaluations under different parameters. There is lack of research about the influence of the transition for a single retiree. Lin and Ding (2007) and Zhang (2008) compared the two policies by actuarial models. The results of Lin and Ding showed that the 2005 policy was an improvement; however, they only considered the case under a high wage growth rate and a low rate of return on investment. Zhang indicated that the new policy would lead to insufficiency under non-continuous employment and equal rates, but hadn't considered other situations. This paper will introduce a simple model to analyze the differences per person between the two arrangements under richer set of policy parameters.

There are six chapters in this thesis.

First chapter is introduction, containing research background, structure of the paper and the methods used further.

In the second chapter, I expound the process of China's pension reform and the related concepts of pension system, focusing on the period 3, which is discussed in modeling approach later.

In the third chapter, I compare the features of new and old policies; especially in details the policy transition effects for retirees. The comparisons are performed in the differences of contribution rates and benefits, both from social pool and individual accounts.

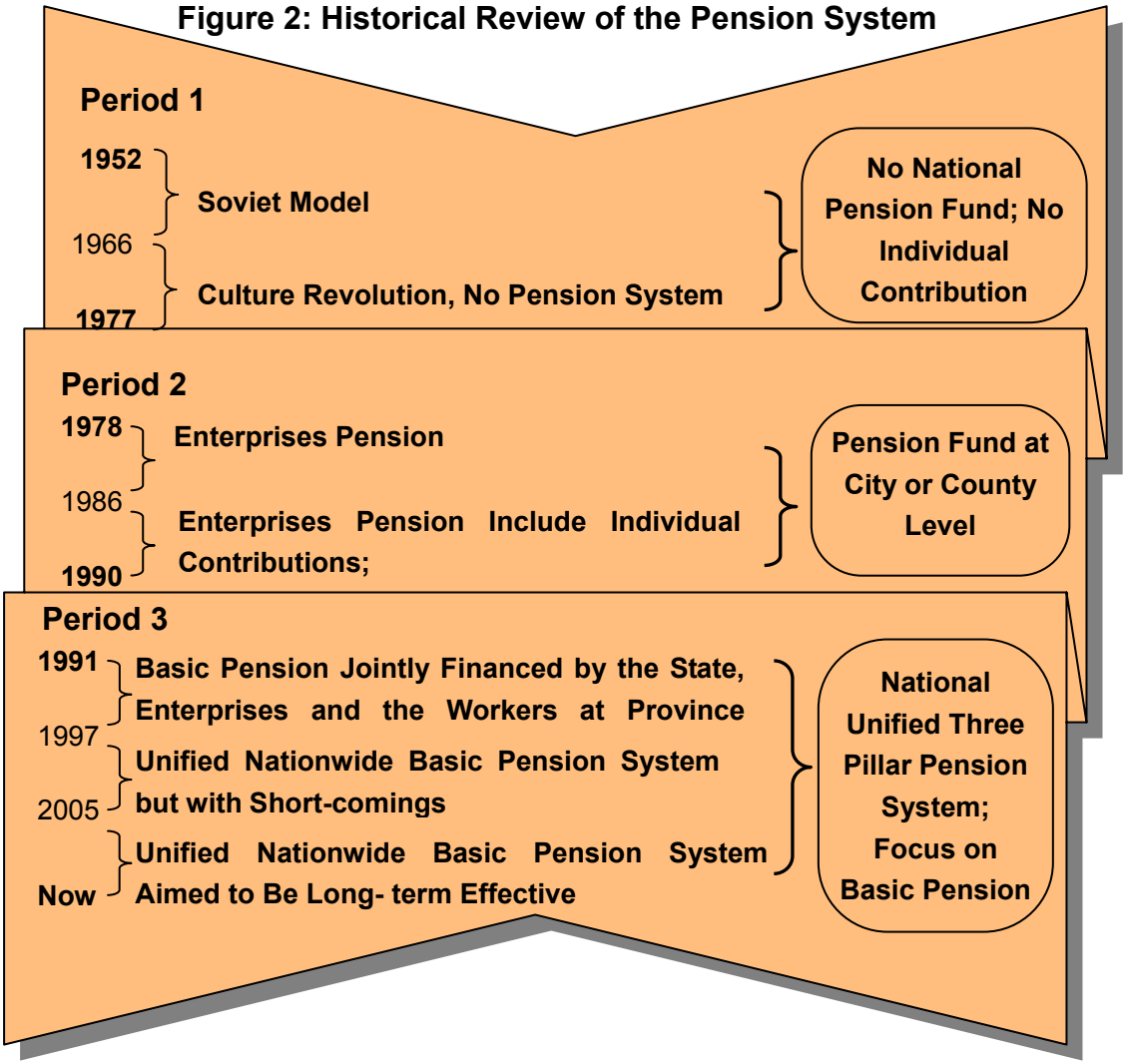
In order to analyze the exact quantitative effects of new policy to a single retiree, an actuarial model is defined in chapter 4, which is followed by calibration.

Based on the calibrated parameters, I use Excel to perform numerical analysis and to calculate the replacement rates under several situations. The results presented in Chapter 5 indicate that males will benefit from new policy slightly while females will suffer from reduction in pension, especially female workers in blue-collar jobs. The difference between males and females is mainly because the retirement age, which is strictly regulated. Cases under non-continuous employment will indicate possible ways to raise the replacement rates, which include adjusting the statutory retirement ages, raising the contribution rate or the combination of both.

The last chapter contains the conclusion of results and policy suggestions.

2. Pension Reform in China

Figure 2: Historical Review of the Pension System



2.1 First Establishment (1952-1977)

People's Republic of China was founded in October 1949, and its first pension policy, which was called "Regulations on Labor Insurance" (1952 Regulations), was promulgated in February 1952. The Regulations were patterned after the Soviet model and they covered nearly all urban workers. The main concept of the regulation was that the DB (defined benefit) pensions of all urban retirees were fully financed by government.

The statutory retirement ages of workers were first defined in the 1952 Regulations, and had been in effect till today. Male workers are eligible for a pension at age 60. For female workers the qualifying age is either 50 or 55 (according to the sectors which they worked in: in "blue-collar jobs" it is 50

while in “salaried positions” it is 55”). The pension of a single person was typically 50 to 70 percent of his/her standard wage of the preceding working year. The replacement rate was depended on the number of years he/she was in employment, with the minimum employment length of 25 years for males; and 20 years for females.

The Regulations were almost abolished during the Culture Revolution (1966-1976) since the pension fund financed by government was considered as a violation of communism principles. During these years, individual enterprises became responsible for pension provision. Moreover, there were no policies or laws to regulate the behavior of enterprises. Therefore, most workers kept working after reaching retirement ages and postponed retirements for many years.

This situation caused a very serious problem after Culture Revolution. There were no national or local pension funds while hundreds of thousand of workers needed to retire in 1976. Moreover, there were also many younger workers seeking for jobs, who had been sent to rural China during the Cultural Revolution and were returning to the cities after 1976.

2.2 Re-establishment (1978-1990)

In 1978 the State Council amended the retirement components of the “Labor Insurance Regulations” (1978 Amendments) to encourage workers who had already achieved their retirement ages or nearly achieved this ages to leave the labor force. As compensation, the one who retired could send one of his/her children to the same company as a full time worker, and the retiree himself/herself could get a pension about 60 to 75 percent of his/her standard wage. The 1978 amendments formalized the practices of enterprises bearing full responsibility for all of the labor insurance benefits (including old age retirement plans) for employees (Fuery, M., Stanton, D. and Walters, C., 1996).

After the Amendments, the number of pensioners nearly doubled in 1978-1979. The unemployment issue seemed to have been solved. However, what

followed was a huge increase in pension expenditures. The pension expenditures increased almost 19 times between 1978 and 1988 while the ratio of pensioners to workers changed from 30.3 workers per pensioner (1978) to 6.4 (1988)(Chai, 1992).

To reduce the costs for enterprises and to establish a more effective pension system, the Chinese government first included individual contributions in the pension system in 1986 Regulations, which prescribed all new employees to contribute 3 percent of their standard wages to social pension fund and the employers to top it up with 15 percent of the wage. Meanwhile, a new institution called Social Insurance Agencies (SIA) was founded to collect and administrate pension funds. At the beginning of 1990s, most cities and counties had their own SIAs.

In this period, there was no unified pension system. SIAs were just local institutions at city or county level. Their responsibilities were to collect and administrate pension funds in pay-as-you-go (PAYG) system.

2.3 Re-design (1991 till now)

2.3.1 1991 Reform

From the beginning of 1990s, ageing problem becomes more and more serious in China. The old PAYG system was difficult to be self-sufficient and caused inequality among different parts of the country. At the same time, “Reform” became very popular in all areas of China’s economy. In 1991, a pension policy named “Resolution on the Reform of the Pension System for Enterprise Workers” (1991 Resolution) was published. In the Resolution, the State Council first aimed to establish a unified three pillar pension system. These were a basic pension for all retirees jointly financed by the state, enterprises and the workers; a supplementary scheme funded by the enterprises from their trading surplus; and accounts funded by individual workers on a voluntary basis, payable at retirement as a lump sum (Whiteford, 2003).

The significant development after 1991 Resolution was large expansion of pension coverage. The coverage of pension insurance of urban employees rose from 38.9% to 52.9% in the first year and kept growing from then on (see Table 1).

Table 1: Big Improvement of Coverage Due to 1991 Reform

Year	Contributors and Recipients (10,000 persons)	Urban Employees (10,000 persons)	Coverage (% of urban employees)
1989	5710.3	14390	39.7%
1990	6166.0	17041	36.2%
1991	6740.3	17465	38.6%
1992	9456.2	17861	52.9%
1993	9847.6	18262	53.9%
1994	10573.5	18653	56.7%

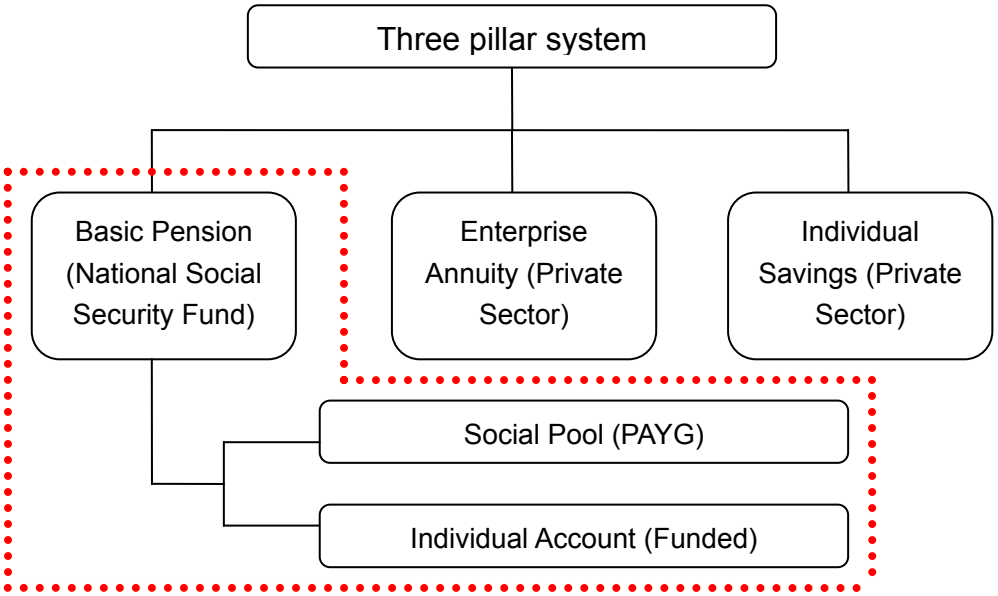
Data from: China Labour Statistical Yearbook 2008.

However, since the 1991 Resolution still encouraged provinces to develop their own new fully funded programs, the Three Pillar system in 1991 Resolution had been more like a guideline than a plan until 1997.

2.3.2 1997 Policy

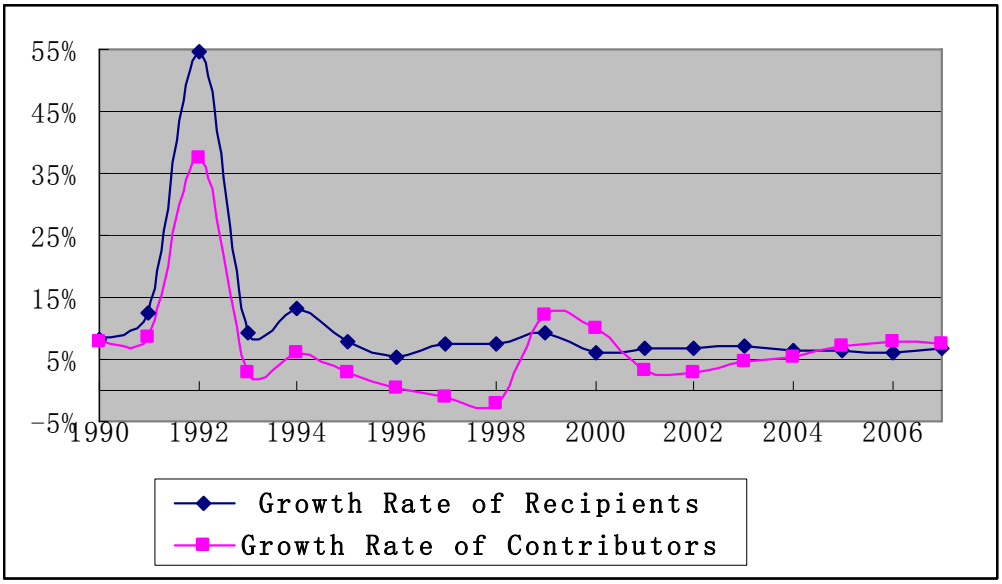
Because under 1991 Resolution, the social security system designs and the relative funds were both at the province level, in 1997, the State Council promulgated “Decision of the State Council on Establishment of Unified Basic Old Age Insurance System for Enterprise Staff and Workers” (1997 Policy), which approved a plan to finally establish a unified nationwide basic pension system - Three Pillar system to replace all former programs in provinces by the end of the 20th century. Since the second pillar “enterprise annuity” and the third pillar “individual saving” are both voluntary and of private sector, the central government is focusing on the first component, the basic pension, which is funded through a national pension fund (NPF; included in the National Social Security Fund, NSSF) for more people (See Figure 3).

Figure 3: Structure of the Three Pillar Pension System



Due to 1991 reform, the coverage of pension system increased significantly. However, since ageing problem and different regulations among provinces, the growth rate of recipients was much higher than that of contributors for many years (See Figure 4). Therefore, in phase 1 (1991-1997) of Period 3, the dependency ratio dropped down quickly while the coverage expanded (See Figure 5).

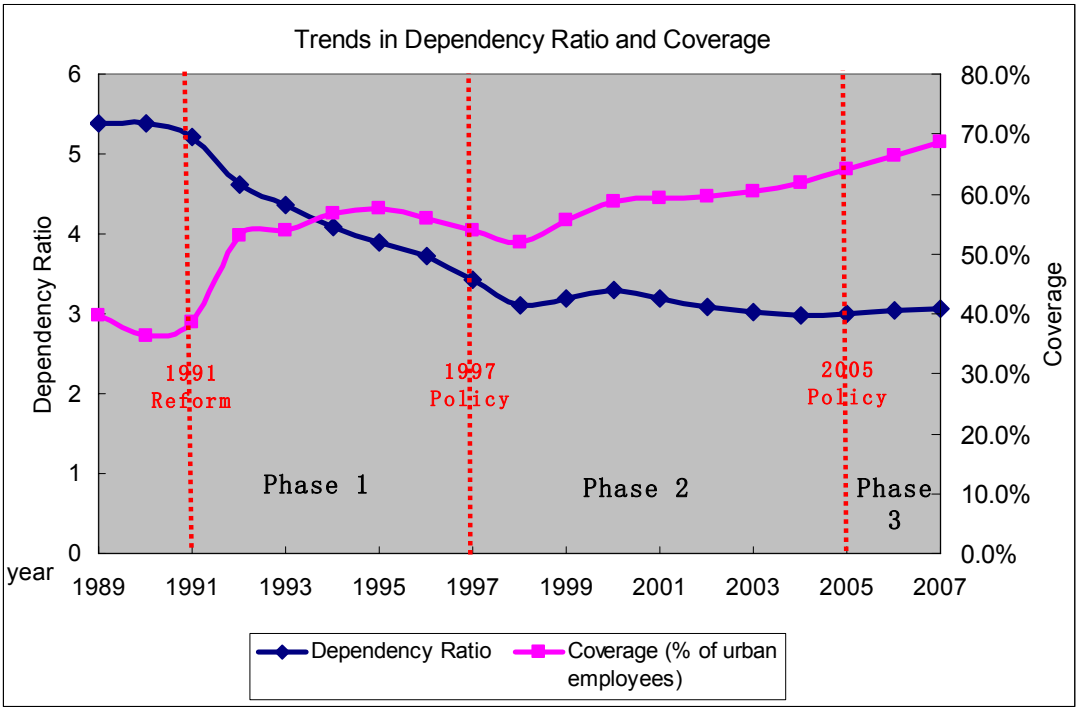
Figure 4: Growth Rates of Recipients and Contributors (1990-2007)



Data from: Appendix 1

Since 1997 Policy introduced a unified funded pension system and began to cover more workers from institutions and state organizations, the number of contributors started to increase from1998, while the growth rate of the number of recipients kept around 6.5%. The difference between the two ratios reduced. Therefore, from 1998, because the coverage rate kept rising, the expansion of the system stopped the decrease of the dependency ratio and had kept it around 3 for ten years (See Figure 5).

Figure 5: Trends in Dependency Ratio and Coverage (1989-2007)



Data from: Appendix 1

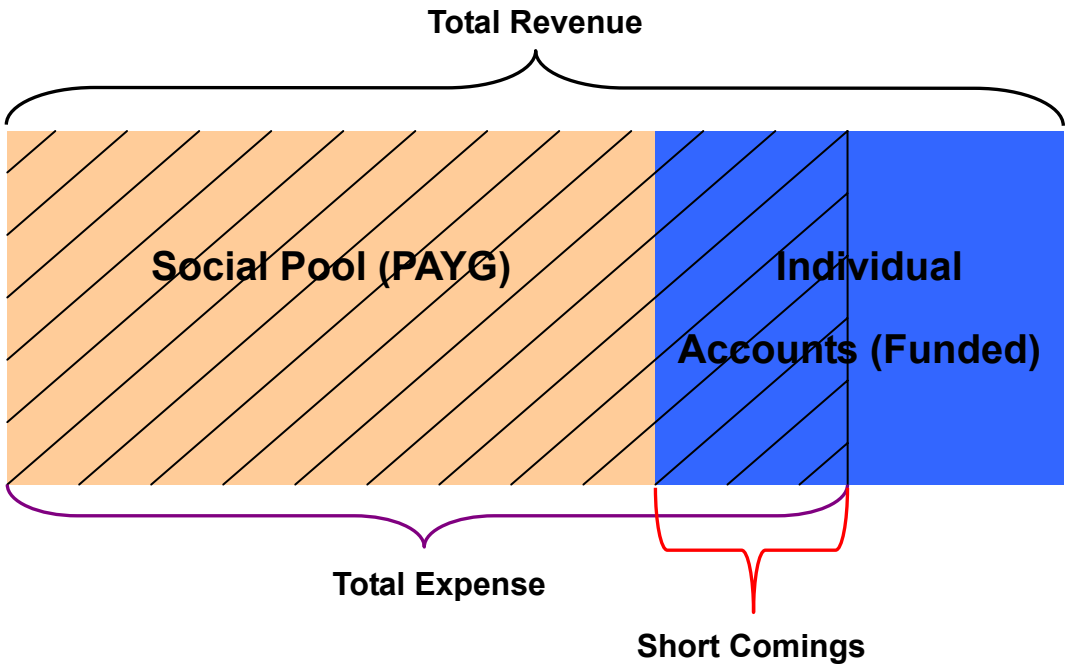
The 1997 Policy also prescribed that both the employers and the employees should contribute to the national pension fund. The employees' contributions were no longer voluntary. All of the employees' contributions and part of the employers' contributions goes to the employees' individual accounts (up to 11% of the preceding year's average standard wages), the rest goes to the social pool for redistribution (more details in Chapter 3). The social pool works on a pay-as-you-go basis while the individual accounts are fully funded, so this arrangement is also known as "partially privatizing". The addition of mandatory

employees' contributions aimed to reduce the expenditure of the government and make the pension fund to be balanced.

2.3.3 2005 Policy

The social pool and the individual accounts were to be managed in segregated accounts by the system design. However, in practice, when the expenditure was over the income in social pool, fund managers usually drew from individual accounts, which resulted in short-comings in individual accounts (See Figure 6). This resulted in a fraction of individual accounts which became "idle accounts". The sum of short-comings in the individual accounts was 14 billion (CNY) in 1997, 45 billion (CNY) in 1998, and over 100 billion (CNY) at the end of 1999. The total revenue of pension fund in these years was 133.8 billion (CNY) in 1997, 145.9 billion (CNY) in 1998, and 196.5 billion (CNY) in 1999. 70%-80% of the short-comings should be compensated by both central and local government later.[1]

Figure 6: Short Comings in Individual Accounts



[1] Data from: Institute for Social Insurance Studies, China, Report 2000

Therefore, Chinese central government began to do some experiments to develop a long-term effective pension system from December 2000. The first step was to reduce the accumulation rate of individual account from 11% to 8% while keeping the total contribution rate at the level of 25% in Liaoning province in 2001[2], and then to expand this to all the Northeastern three provinces (Liaoning, Jilin, Heilongjiang) by the end of 2003. According to Zheng (2006), the experiments proved to be successful. Most of these managerial goals have been achieved and individual accounts became fully funded in Jilin and Heilongjiang provinces.

Thanks to the successful outcome and China's 11th five-year plan (2006-2011) to create a "harmonious society", in December 2005, State Council Promulgated "Decision on Improving the System of Basic Old-age Pension Insurance for Enterprise Staff and Workers" (2005 Policy) to implement the new contribution and benefit method nationwide.

2. 4 Chinese System in Comparative Perspective

Based on the comparisons with other regions of the world in Table 2, 3 & 4, the following conclusions about Chinese pension system can be made:

1) The coverage rate of the pension system is lower than those of OECD countries, but close to or more than those of other regions. However, the coverage rate of China is just the participants per urban labor force; while more than half of Chinese population lives in the rural China and are not included in the pension system coverage calculations (See Table 2).

2) The contribution rates in China are very high compared to those of other regions. But these contribution rates contain both employers' contribution and employees' contribution, and these are policy target values (See Table 2, more in Sec. 3.4).

[2] According to Document 42 (State Council, 2000) and Articles 79 (State Council, 2001)

Table 2: Coverage and Contribution Rates, Compared to Selected World Regions

Region		Coverage (%)	Contribution Rates (Pension Contributions/Wages; %)
China			
	1995	58*	20
	1999	56*	25
	2005	64*	28
OECD		90	19
Range		79-98	6-35
Asia and the Pacific		26	14
Range		3-73	3-40
Central and Eastern Europe and Former Soviet Union		66	22
Range		32-97	20-45
North Africa and Middle East		41	13
Range		30-82	3-27
Sub-Saharan Africa		6	10
Range		1-18	3-24
Latin America and Caribbean		33	12
Range		11-82	3-29

Data from: * are from China Statistical Yearbook 2008, only for urban employees; others are from Salditt, F., P. Whiteford and W. Adema (2007), PP 33, Table 8.

3) The replacement rate in China seems higher than the average values of most of other regions; however, most retirees in other regions such as OECD countries have other finance supports besides mandatory pension programs. As I stress out before, in China the second pillar “enterprise annuity” and the third pillar “individual saving” are both voluntary and of private sector, thus the additional pension is not regular for most workers. Since the basic pension is the only income of most retirees in China, the replacement rate is not high (See Table 3).

4) The statutory retirement age for female in China is lower than most of other Asian countries (See Table 4).

Table 3: Average Gross Replacement Rates (%) by Earnings Level, Mandatory Pension Programs, Men (Percentage of individual pre-retirement gross earnings), Compared to Selected World Regions

High-income OECD countries								
Australia	40	France	49.4	Japan	50.3	Portugal	66.7	
Austria	78.3	Germany	45.8	Korea, Rep. of	40.6	Spain	80.1	
Belgium	37.3	Greece	84	Luxembourg	101.9	Sweden	64.8	
Canada	42.5	Iceland	52.8	Netherlands	68.3	Switzerland	58.2	
Denmark	43.3	Ireland	30.6	New Zealand	37.6	United Kingdom	37.1	
Finland	71.5	Italy	78.8	Norway	52.6	United States	40.3	
						Average	**56.4**	
Eastern Europe and Central Asia								
Bulgaria	49.7	Estonia	51.6	Lithuania	53.4	Slovak Republic	48.6	
Croatia	38.4	Hungary	75.4	Poland	56.9	Turkey	87.2	
Czech Republic	44.4	Latvia	58.2			**Average**	**56.4**	
Middle East and North Africa								
Algeria	80	Egypt, Arab Rep. of	85.3	Libya	80	Tunisia	64	
Bahrain	79.2	Iran, Islamic Rep. of	115.5	Morocco	70	Yemen, Rep. of	100	
Djibouti	37.5	Jordan	67.5			**Average**	**77.9**	
Latin America and the Caribbean								
Argentina	62.6	Costa Rica	89	El Salvador	38.7	Peru	39.1	
Chile	43.8	Dominican Republic	52.6	Mexico	36	Uruguay	102.6	
Colombia	50					**Average**	**57.2**	
China	59*							

Data from: * is Chinese pension replacement rate in 2005, from Salditt, F., P. Whiteford and W. Adema (2007), PP 33; others are in 2002, from Whitehouse (2007), PP 32.

Table 4: Retirement Age, Compared to Selected Asian Economics

Country	Retirement Ages	
	Males	Females
China	60	55/50
India	58	58
Indonesia	55	55
Pakistan	60	55
Philippines	60	60
Sri Lanka	55	50
Thailand	55	55
Vietnam	60	55
Hong Kong	65	65
Korea	60	60
Malaysia	55	55
Singapore	55	55

Data from: Salditt, F., P. Whiteford and W. Adema (2007), PP 33

3 Comparisons between 1997 Policy and 2005 Policy

The biggest difference between the two policies is “funding individual accounts of the basic pension system”. The changes are both in contribution rate and in benefit formula.

Table 5: Contributions and benefits under two policies

		1997 Policy	2005 Policy
Contributions (up to 28% of employee’s Wages)	**Social Pool**	Up to 17% of employee’s standard wage [(1)]	Up to 20% of employee’s standard wage
	Individual Account	Up to 11% of employee’s standard wage	Up to 8% of employee’s standard wage
Benefits	**Social pool Pension**	20% of local average wage of the preceding year (if >15 years contribution [(2)]).	1% of combining average wage [(3)] per each contribution year (if >15 years contribution).
	Individual Account Pension	Individual account terminal value divided by 10 years (120 months)[(4)]	Individual account terminal value divided by the actuarial factor at the retirement age[(5)]

Some explanations for Table 5:

(1) Standard wage: not exactly the employee’s nominal basic wages; it is constrained by a maximum base of three times the average local (provincial) wages and a minimum of 60% of this average.

(2) If an individual has contributed for less than 15 years, he/she will receive the savings from the individual account as a lump sum, no social pool pension.

(3) Combining average wage: half is the local average wage of the preceding year; half is the employee’s standard wage of the preceding year.

(4) 10 years (120 months): the divisor factor 10 years (120 months) is based on an assumption that average post-retirement lifetime is 10 years. The individual account pension is drawn from the funded account in these 10 years. And if the retiree lives longer than 10 years, the extra individual account pension is paid out of the social pool.

(5) The actuarial factor at the retirement age: Due to the change of life expectancy, the individual account divisor factor changes from the certain number (120 months) to an actuarial base factor varying with the retirement ages (see Table 6).

Table 6: Actuarial Factor of Different Retirement Ages

Retirement Age	Actuarial Factor (Months)	Retirement Age	Actuarial Factor (Months)
45	216	56	164
46	212	57	158
47	208	58	152
48	204	59	145
49	199	60	139
50	195	61	132
51	190	62	125
52	185	63	117
53	180	64	109
54	175	65	101
55	170		

Data from: the attachment of 2005 Policy, State Council [2005] No.31

3.1 Accumulation Rate Rise in social pool

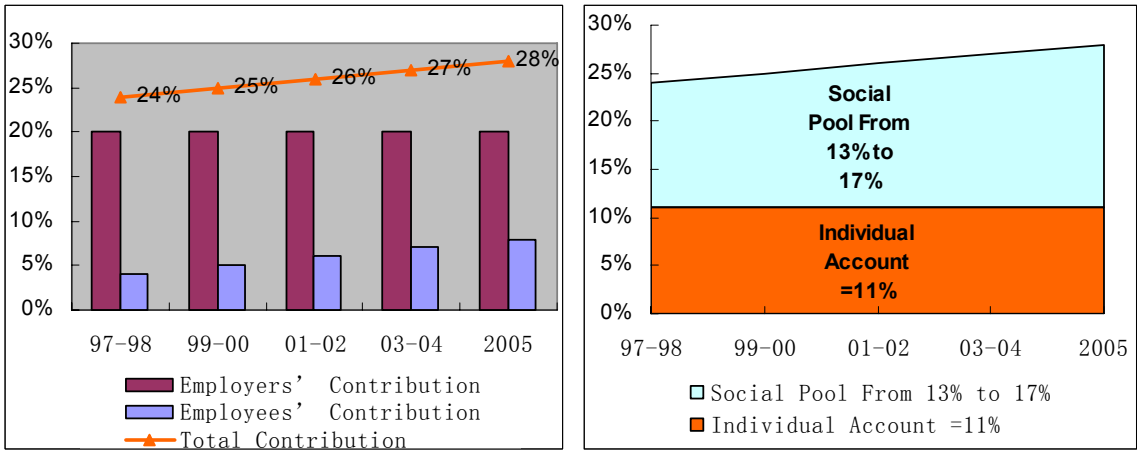
In 1997 Policy, at first year, the employees should have contributed 4% of their standard wage, and then increasing by 1% every two years till the rate reached 8% in 2005; and the employers' total contribution rate was 20% in all the years 1997-2005. 11% of the standard wage should have gone into the employees' individual account, which meant that in 1997, the employers should have

contributed 7% of the standard wage to the individual account and this rate fell to 3% in 2005 (see Table 7 and Figure 7).

Table 7: Contribution Rates in 1997 Policy

year	Individual Account (11%)		Social Pool	Total Contribution
97-98	Employees' Contribution: 4%	Employers' Contribution: 7%	Employers' Contribution: 13%	24%
99-00	Employees' Contribution: 5%	Employers' Contribution: 6%	Employers' Contribution: 14%	25%
01-02	Employees' Contribution: 6%	Employers' Contribution: 5%	Employers' Contribution: 15%	26%
03-04	Employees' Contribution: 7%	Employers' Contribution: 4%	Employers' Contribution: 16%	27%
2005	Employees' Contribution: 8%	Employers' Contribution: 3%	Employers' Contribution: 17%	28%

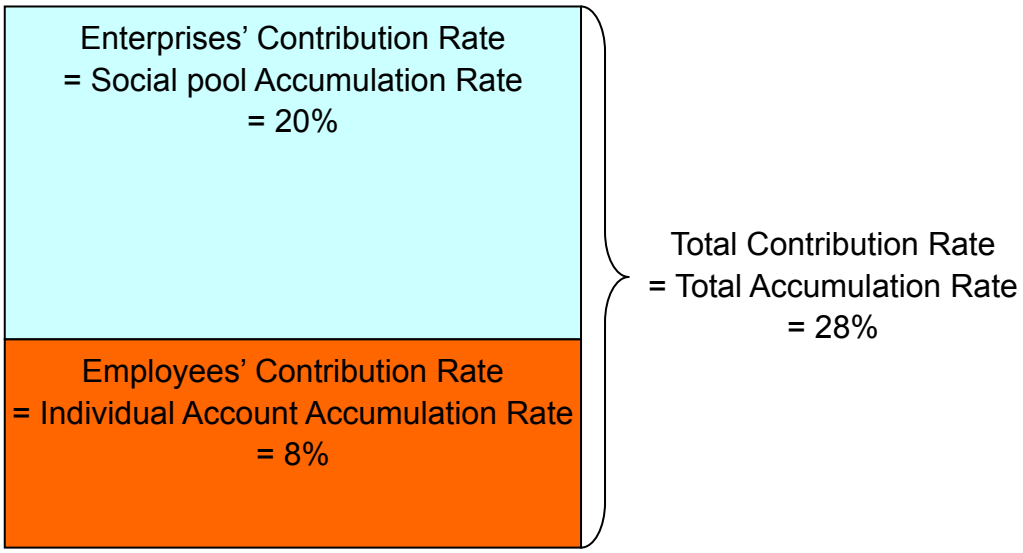
Figure 7: Contribution Rates and Account Accumulation Rates in 1997 Policy Design



Data from: Appendix 2

Correspondingly, in 2005 Policy, from 2006 all the employers' contributions (20%) had to go into the pay-as-you-go social pool while the individual accounts should be funded all by the employers (see Figure 8), which means 3% of the standard wages transfer from individual account to social pool compared with 1997 Policy.

Figure 8: Contribution Rates and Account Accumulation Rates in 2005 Policy Design



3.2 Changes in Benefits from Social Pool

The Social Pool pension changed in two ways.

First change is the replacement rate. In 1997 Policy (old policy), the replacement rate was certain, while in 2005 Policy, it is varying with the year of contribution. In the old policy, if the minimum contribution requirement of 15 years reached, the retiree would get 20% of the local average wage of the preceding year from the social pool, no matter how many years he/she contributed. However, in the new policy, besides minimum contribution requirement, the retiree gains additional 1 percent point for each year of contributions. The change is meant to reward additional contribution years (see Table 8).

Table 8: Replacement Rates of Social Pool Pension under Two Policies

Contribution Years / Policy year	15	18	20	25	35
1997	20%	20%	20%	20%	20%
2005	15%	18%	20%	25%	35%

The second change is the benefits' base. In 1997 Policy, the base was the local average wage of the preceding year. In 2005, the base changes to the combining average wage, which contains half of the local average wage and half of the employee's standard wage of the preceding year. Employees who were at high salary jobs will get higher pension benefits from social pool compared to the situation under 1997 Policy. This term is also an encouragement for contributions to the National Pension Fund.

3.3 Decrease in Individual Account Pension

For most employees who retire before 62 years old, the change from a certain divisor factor (10 years) to a varying actuarial factor (see Table 6) means a decrease in individual account pension.

Meanwhile, following the discussion in Sec. 3.1, the accumulation rate of individual accounts is reduced from 11% to 8%. It means the terminal value of individual accounts under 2005 policy will be less than that under 1997 policy, which also leads to a decrease in individual account component.

3.4 The Influence of the Transition to a Single Retiree

From the analysis above, it is sure that both the accumulation rate rise in social pool and the pension decrease in individual account will result in a reduction of the total pension benefits in 2005 policy compared to 1997 policy. In the same time the change of the calculation rules for the benefits from Social Pool seems to give the advantage to retirees who had longer working years or higher salaries.

According to OECD definition, the old-age pension replacement rate is a measure of how effectively a pension system provides income during retirement to replace earnings which were the main source of income prior to retirement. Therefore, to analyze the quantitative differences per person between the two arrangements, the total pension replacement rate is a

suitable measure. Before I start to lay out the model, two things should be clarified.

First, under the new policy, the maximum of employee and employer contributions are set respectively to 8% and 20% of the standard wage (Sum is 28%), but in practice there is variation in the sum, ranging from 18% to 28% of the total wage. In this work, I use the maximum level for calculation because it is prescribed in the policy and will be reached in the near future. Moreover, this will make the results stronger because other numerical values under 28% will cause higher insufficiency of the replacement rates.

The other important problem rises because of system transition. As discussed in Chapter 2, China's pension system has changed much for the past 60 years. Therefore, there are "old" retirees and "old" employees who don't have full individual accounts. The 2005 Policy divided all the workers in pension system into three groups. People who retired before 1997 are "old" persons; those who started to work but didn't retired before 1997 are called "middle" persons; those who started to work after 1997 are "new" persons. Only "new" persons have accumulations in individual accounts from when they started work. Therefore, in 2005 policy regulations, the pension for "old" persons has to follow the regulations which were in policies before 1997, while that of "middle" persons has to follow 1997 Policy. Only "new" persons should obey 2005 Policy regime, so the transition to the new policy only influences "new" employees.

4. Modeling Approach - The Replacement Rate

Definitions

Consider a pension for a single new retiree. Let me introduce the following notations:

R – Retirement age

A – The terminal value of individual pension account

φ^i – Accumulation rate of individual pension account under i policy (the superscript i=1 means the old policy; i=2 means the new one)

t – Age

w_t – Wage at age t

a – Initial working age; the age the individual starts first job and begins to contribute to the pension system

$s(a,t)$ – The probability of employment and thus a contribution to the pension system at age t ($s(a,t)$=1 if employed, $s(a,t)$ = 0 if unemployed)

i_t – Rate of return on investment in year t

g_t – Growth rate of wage in year t

U_R – The average number of unemployment years before retirement in the population

$S_R^{\ i}$ – Social pool pension of the first retirement year under i policy (the superscript i=1 means the old policy; i=2 means the new one)

$I_R^{\ i}$ – Individual account pension of the first retirement year under i policy (the superscript i=1 means the old policy; i=2 means the new one)

$T_R^{\ i}$ – Total pension of the first retirement year under i policy (the superscript i=1 means the old policy; i=2 means the new one)

$\rho_R^{\ i}$ – The replacement rate at the first retirement year under i policy (the superscript i=1 means the old policy; i=2 means the new one)

G_R – The actuarial factor of retirement age R under new policy in years (See Table 6 & 9)

4.1 Contributions and Growth in Individual Pension Account

I depart from the actuarial calculations in (Bowers, N.L., Gerber, H.U., Hickman, J.C., Jones, D.A. and Nesbitt, C.J., 1997). When a worker retires at age R, the theoretical terminal value of his/her individual pension account is,

$$A = \sum_{t=a}^{R-1} \varphi w_{t-1} s(a,t) \left[\prod_{n=t}^{R-1} (1+i_n) \right] \quad (1)$$

For example, at age u, if the worker has a job ($s(a,u)$=1), he/she contributes to the pension system. The accumulation to his/her individual pension account at the age u is φw_{u-1}, which is the product of accumulation rate of individual pension account φ and the preceding year's average wage w_{u-1} (According to Chinese pension policy, this year's contribution is based on the preceding year's average wage). φw_{u-1} grows by the rates of return on investment of national pension fund. Therefore, when he/she retires at age R, it will be $\varphi w_{u-1} \prod_{n=u}^{R-1} (1+i_n)$.

Assumption A1: The rates of return on investment are equal among years, viz. $i_t \equiv i$.

This Equation (1) simplifies to,

$$A = \sum_{t=a}^{R-1} \varphi w_{t-1} s(a,t) (1+i)^{R-t} \quad (2)$$

Equation (2) means that when the individual retires, the terminal value of his/her individual account is the accumulation of his/her contributions during working years under compound interest rate.

Assumption A2: The growth rates of wage are equal among years, viz. $g_t \equiv g$.

Then it follows that,

$$w_{t-1} = w_a (1+g)^{t-1-a}$$

Similarly, we can get his/her average wage of the last working year,

$$w_{R-1} = w_a(1+g)^{R-1-a}$$

Viz., $$w_a = w_{R-1}(1+g)^{a+1-R}$$

Therefore, $$w_{t-1} = w_{R-1}(1+g)^{t-R} \quad (3)$$

Insert (3) into (2); we get the final expression of the terminal value of his/her individual pension account, which is,

$$A = \sum_{t=a}^{R-1} \varphi w_{R-1} s(a,t) \left(\frac{1+i}{1+g}\right)^{R-t} \quad (4)$$

4.2 Pension and Replacement Rate in the First Retirement Year

Since this paper aims to analyze how the new policy influences an individual's pension benefit, this person should be a very "common" person. In other words, this common person's wage should be the average wage, i.e. $w_{R-1} = \overline{w}_{R-1}$, and the number of years he/she is unemployed is just the average number of unemployment years in the population U_R.

4.2.1 Pension and Replacement Rate under 1997's Policy

The social pool pension is 20% of the preceding year's average wage,

$$S_R^{\,1} = 20\% * \overline{w}_{R-1} = 20\% * w_{R-1}$$

The individual account pension is the terminal value divided by 10 years (the defined pension payment years under 1997's),

$$I_R^{\,1} = A/10$$

The total pension thus is

$$T_R^{\,1} = 20\% * w_{R-1} + A/10$$

The replacement rate under 1997's is,

$$\rho_R^{\,1} = (20\% * w_{R-1} + A/10)/w_{R-1} = 0.2 + A/(10w_{R-1})$$

From Equation (4), we get,

$$\rho_R^{\,1} = 0.2 + 0.1\sum_{t=a}^{R-1} \varphi^1 s(a,t) \left(\frac{1+i}{1+g}\right)^{R-t} \quad (5)$$

4.2.2 Pension and Replacement Rate under 2005's Policy

The social pool pension is: based on the preceding year's average wage, 1% per a working year,

$$S_R^{\,2} = 1\% * (R - a - U_R) * (w_{R-1} + \overline{w}_{R-1}) / 2 = 1\% * (R - a - U_R) * w_{R-1}$$

The individual account pension is the terminal value divided by G_R years,

$$I_R^{\,2} = A / G_R$$

The total pension is

$$T_R^{\,2} = 1\% * (R - a - U_R) * w_{R-1} + A / G_R$$

The replacement rate under 2005's is,

$$\rho_R^{\,2} = [1\% * (R - a - U_R) * w_{R-1} + A / G] / w_{R-1} = (R - a - U_R) * 0.01 + A / (w_{R-1} G_R)$$

From Equation (4), we get,

$$\rho_R^{\,2} = (R - a - U_R) * 0.01 + \sum_{t=a}^{R-1} \varphi^2 s(a,t) \left(\frac{1+i}{1+g} \right)^{R-t} / G_R \qquad (6)$$

4.3 Calibration of the Model

4.3.1 Policy Fixed Parameters

Parameter P1: φ – Accumulation rate of individual pension account

According to the regulations discussed in Chapter 3, in 1997 policy, the accumulation rate of individual pension account φ^1 is 11%, so it follows,

$$\rho_R^{\,1} = 0.2 + 0.011 \sum_{t=a}^{R-1} s(a,t) \left(\frac{1+i}{1+g} \right)^{R-t} \qquad (7)$$

In 2005 policy, the accumulation rate of individual pension account φ^2 is 8%, so it follows,

$$\rho_R^{\,2} = (R - a - U_R) * 0.01 + 0.08 \sum_{t=a}^{R-1} s(a,t) \left(\frac{1+i}{1+g} \right)^{R-t} / G_R \qquad (8)$$

Parameter P2: a– Initial working age

Based on Chinese 2000 census, Zheng (2002) estimated the initial working ages in China, to be 19.2 for male and 19.1 for female. Since retirement and pension are considered on year bases in this paper, I set a = 19 in the following discussion.

Parameter P 3: R– Retirement age

According to Chinese policy, the statutory retirement age is 60 for men, 55 for women in salaried positions, and 50 for women in blue-collar jobs. Those working in designated harsh or dangerous conditions may retire five years earlier; senior professionals may retire five years later. As the explanation at the beginning of Sec. 4.2, the retiree is a common person, I assume that he/she will retire immediately when achieving statutory retirement age with no advancing or postponing.

Parameter P4: G_R – The actuarial factor of retirement age R under new policy (in years)

According to Table 6, G_R is as following:

Table 9: The Actuarial Factor G_R

Retirement Age	G_R (Years)	Retirement Age	G_R (Years)
45	18.00	56	13.67
46	17.67	57	13.17
47	17.33	58	12.67
48	17.00	59	12.08
49	16.58	60	11.58
50	16.25	61	11.00
51	15.83	62	10.42
52	15.42	63	9.75
53	15.00	64	9.08
54	14.58	65	8.42
55	14.17		

Data from: the attachment of 2005 Policy, State Council [2005] No.31

4.3.2 Flexible Parameters

Parameter P5: $s(a,t)$ – The probability that the individual is employed and contributes to the pension system at age t.

$s(a,t)$ has two values: $s(a,t)$ =1 if he/she has a job; $s(a,t)$ = 0 if he/she hasn't a job.

In this paper, I consider two cases.

First, continuous employment: $s(a,t) \equiv 1$ for all years before retirement (viz. U_R=0). This case is discussed in Section 5.1

Second, non-continuous employment: $s(a,t)$ = 0 at some years (viz. $U_R \neq 0$). This case is discussed in Section 5.2

Parameter P6: $\left(\frac{1+i}{1+g}\right)$ – Relation between investment interest and wage growth factors

In the past ten years, the growth rate of nominal wage has kept above 10% per year, while the investment interest rate of National Social Security Fund (NSSF, containing National Pension Fund) is only about 3% per year on average.

However, since the GDP growth is slowing down and unemployment rate is rising, the growth rate of wage can not maintain in that high level. On the other hand, NSSF have expanded the range of investment by increasing the proportion of abroad investment and stock market investment since 2006, so it is reasonable that the interest rate of NSSF investment will rise in the future.

The experience of NSSF in other countries can support the assumption that the investment rate i can be equal to or higher than wage growth rate g .

Therefore, I consider two cases when $i = g$ and $i \neq g$.

$i = g$; discussed in Section 5.1.1 & 5.2

$i \neq g$; discussed in Section 5.1.2

4.3.3 Main Groups of workers

According to Chinese policy, except senior professionals and those working in designated harsh or dangerous conditions, the workers are divided into three groups as shown in Table 10.

Table10: Three Types of Workers

Type	Jobs	Statutory Retirement Age	G_R in years
Male	All	60	11.58
Female 1	In salaried positions	55	14.17
Female 2	In blue-collar jobs	50	16.25

Data from: “Regulations on Labor Insurance” (1952 Regulations)

5. Numerical Results

5.1 Results under Continuous Employment

It is obvious that the replacement rate under non-continuous employment is less than that of continuous employment. And as discussed in Ch 3, the new policy is an advantage for retirees who had longer working careers. Thus if under continuous employment, the replacement rates under the new policy are less than those under the new one ($\rho_R{}^2 < \rho_R{}^1$), it is sure that under non-continuous employment, $\rho_R{}^2$ is also less than $\rho_R{}^1$. Therefore I first consider the model under continuous employment assumption.

Assumption B1.1: This retiree has a continuous employment before retirement; i.e. $s(a,t) \equiv 1$ for all the years (viz. U_R=0).

5.1.1 Replacement Rates under Two Policies when $i = g$

Assumption B2.1: g and i are equal in all the years.

Model after B2.1: Since $i = g$, we get,

$$\left(\frac{1+i}{1+g}\right)^{R-t} = 1.$$

With $s(a,t) \equiv 1$ and U_R=0, then equation (7) will be:

$$\rho_R{}^1 = 0.2 + 0.011\sum_{t=a}^{R-1} 1$$

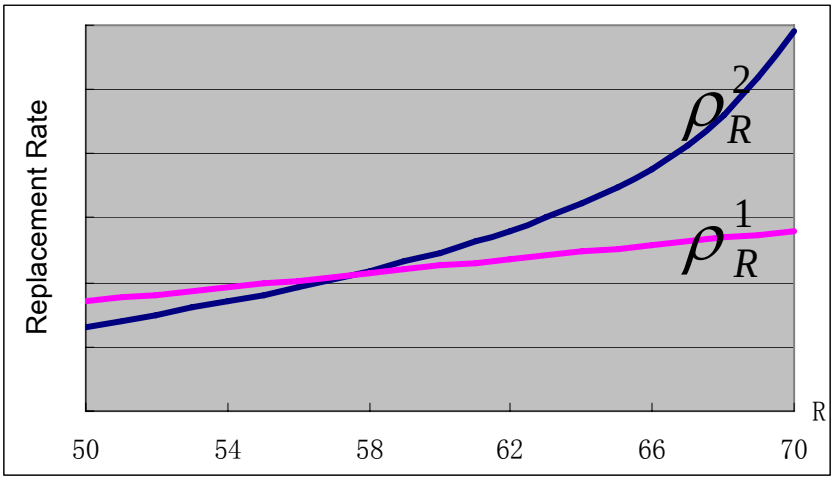
$$\text{Viz.} \quad \rho_R{}^1 = 0.2 + 0.011(R-a) \tag{9}$$

In the same way, equation (8) will be:

$$\rho_R{}^2 = (R-a) * 0.01 + 0.08(R-a)/G_R$$

$$\text{Viz.} \quad \rho_R{}^2 = (R-a) * (0.01 + 0.08/G_R) \tag{10}$$

Figure 9: The Relationship between Eq. (9) and (10)



Now I inset the other parameters into the equations of replacement rate to calculate replacement rates of different groups of workers (See Table 11). Male retirees benefit from the transition, while female retirees suffer a reduction in pension benefits, especially the women working in blue-collar jobs who retire at age 50.

Table 11: Replacement Rates (%) under Two Policies

	Male Retirees (R=60; a=19; G_{60}=11.6)	Female Retiree (a=19)	
		in salaried positions (R=55; G_{55}=14.2)	in blue-collar jobs (R=50; G_{50}=16.25)
97 Policy	65.1	59.6	54.1
05 Policy	69.3	56.3	46.3
Difference	4.2	-3.3	-7.8

According to the analysis and assumption in the former sections, both the standard wage and the accumulation rate are the same between males and females. Moreover, their initial working ages are also equal. Therefore, the only factor that causes the different effects of the policy transition is the retirement age (see Table 12). It is clear that there is a strong correspondence between the available benefits and the age departure from the labor force (Jonathan Gruber and David Wise, 1998).

Table 12 Gender Difference in the Effects of Policy Transition

		Male Retiree (R=60)	Female Retiree	
			in salaried positions (R=55)	in blue-collar jobs (R=50)
1997 Policy	Social Pool Pension	20% of local average wage of the preceding year	20% of local average wage of the preceding year	20% of local average wage of the preceding year
	Individual Account Pension: $0.011(R-a)$	45.1% of local average wage of the preceding year	39.6% of local average wage of the preceding year	34.1% of local average wage of the preceding year
2005 Policy	Social Pool Pension: $(R-a)*0.01$	41% of local average wage of the preceding year	36% of local average wage of the preceding year	31% of local average wage of the preceding year
	Individual Account Pension: $0.08*(R-a)/G_R$	28.3% of local average wage of the preceding year	20.3% of local average wage of the preceding year	15.3% of local average wage of the preceding year

In the old arrangement, although women retire also 5 or 10 years earlier than men, since the social pool pension does not correlate with the years of contribution, the difference between male and female retirees is only because of individual account pension. However, in the new policy, the gap exists in both social pool and individual accounts.

In conclusion, when $i = g$, male retirees benefit from the transition, while female retirees suffer a pension reduction, especially the women working in blue-collar jobs, and the only factor that causes the different effects of the policy transition is the retirement age.

5.1.2 Replacement Rates under Two Policies when $i \neq g$

Assumption B2.2: g and i are not equal in different years.

Under $s(a,t) \equiv 1$ and $i \neq g$, Eq. (7) for replacement rates under 1997 policy will be:

$$\rho_R^{\,1} = 0.2 + 0.011\sum_{t=a}^{R-1}\left(\frac{1+i}{1+g}\right)^{R-t} \tag{11}$$

Eq. (8) for replacement rates under 2005 policy will be:

$$\rho_R^{\,2} = (R-a)*0.01 + 0.08\sum_{t=a}^{R-1}\left(\frac{1+i}{1+g}\right)^{R-t} / G_R \tag{12}$$

Now I inset the other parameters into the equations of replacement rate and calculate potential replacement rates for different possible values of i and g (See Table 13&14 and Figure 10).

Table 13: Replacement Rates under 1997 Policy when $i \neq g$ for Men

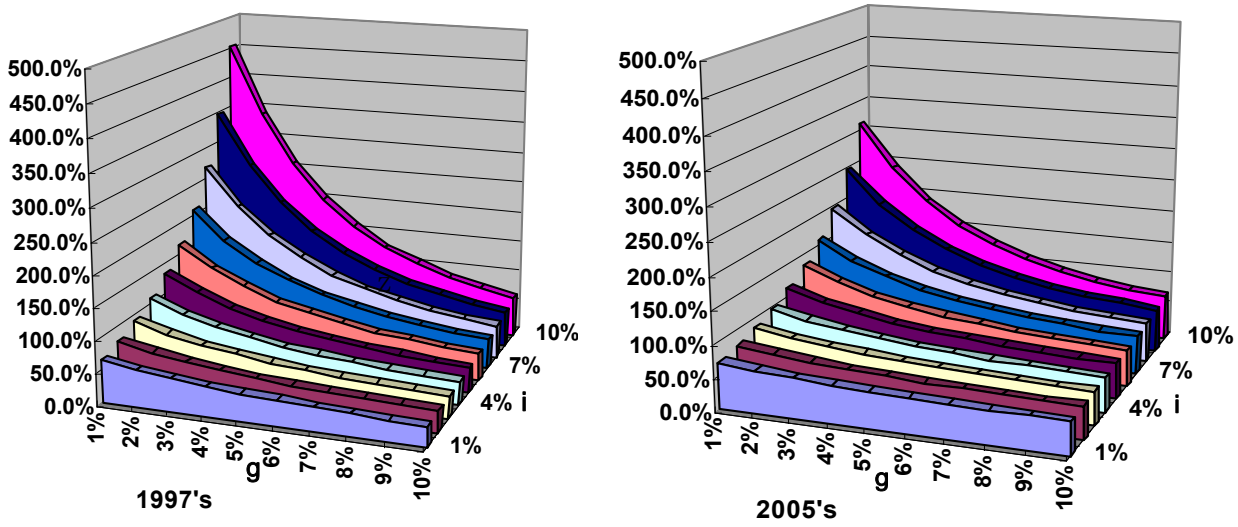
		i									
		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
g	1%	65.1%	75.8%	89.9%	108.5%	133.1%	165.8%	209.4%	267.8%	346.2%	451.7%
	2%	56.9%	65.1%	75.7%	89.6%	107.9%	132.0%	163.9%	206.5%	263.2%	339.2%
	3%	50.7%	57.0%	65.1%	75.6%	89.3%	107.3%	130.9%	162.2%	203.6%	258.8%
	4%	45.9%	50.8%	57.1%	65.1%	75.5%	89.0%	106.7%	129.9%	160.4%	200.9%
	5%	42.1%	46.0%	50.9%	57.1%	65.1%	75.4%	88.7%	106.1%	128.9%	158.8%
	6%	39.2%	42.3%	46.1%	51.0%	57.2%	65.1%	75.3%	88.4%	105.5%	127.9%
	7%	36.8%	39.3%	42.4%	46.3%	51.1%	57.3%	65.1%	75.2%	88.1%	105.0%
	8%	34.9%	36.9%	39.4%	42.5%	46.4%	51.2%	57.3%	65.1%	75.1%	87.9%
	9%	33.3%	35.0%	37.0%	39.5%	42.6%	46.5%	51.3%	57.4%	65.1%	75.0%
	10%	32.0%	33.4%	35.1%	37.2%	39.7%	42.8%	46.6%	51.4%	57.4%	65.1%

Table 14: Replacement Rates under 2005 Policy when $i \neq g$ for Men

		i									
		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
g	1%	69.3%	76.0%	84.8%	96.5%	111.9%	132.4%	159.7%	196.4%	245.5%	311.6%
	2%	64.1%	69.3%	75.9%	84.6%	96.1%	111.2%	131.2%	157.9%	193.5%	241.1%
	3%	60.2%	64.2%	69.3%	75.9%	84.5%	95.7%	110.5%	130.1%	156.1%	190.7%
	4%	57.2%	60.3%	64.2%	69.3%	75.8%	84.3%	95.3%	109.9%	129.1%	154.4%
	5%	54.9%	57.3%	60.4%	64.3%	69.3%	75.7%	84.1%	95.0%	109.2%	128.0%
	6%	53.0%	55.0%	57.4%	60.4%	64.3%	69.3%	75.7%	83.9%	94.6%	108.6%
	7%	51.5%	53.1%	55.0%	57.5%	60.5%	64.4%	69.3%	75.6%	83.7%	94.3%
	8%	50.3%	51.6%	53.2%	55.1%	57.5%	60.6%	64.4%	69.3%	75.5%	83.6%
	9%	49.3%	50.4%	51.7%	53.3%	55.2%	57.6%	60.6%	64.4%	69.3%	75.5%
	10%	48.5%	49.4%	50.5%	51.8%	53.3%	55.3%	57.7%	60.7%	64.5%	69.3%

From the above two tables and Figure 10, we can conclude that the new policy is better when the rate of return on investment of Nation Pension Fund is at a low level. Since low interest rate and high wage growth rate is the situation in China now, it can be considered as a policy improvement.

Figure 10: Replacement Rates under Two Policies when $i \neq g$ for Men (R=60)



However, as the discussion in Sector 5.1.1, the new policy has different effects between men and women. By now, we can't say that the new policy will be a Pareto improvement when $i < g$.

Table 15: Difference between Two Policies for Men (R=60)

		i									
		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
g	1%	4.2%	0.2%	-5.1%	-12.0%	-21.2%	-33.4%	-49.7%	-71.4%	-100.7%	-140.0%
	2%	7.2%	4.2%	0.2%	-5.0%	-11.8%	-20.8%	-32.7%	-48.6%	-69.7%	-98.1%
	3%	9.6%	7.2%	4.2%	0.3%	-4.9%	-11.5%	-20.4%	-32.0%	-47.5%	-68.1%
	4%	11.3%	9.5%	7.2%	4.2%	0.3%	-4.7%	-11.3%	-20.0%	-31.4%	-46.5%
	5%	12.7%	11.3%	9.5%	7.2%	4.2%	0.3%	-4.6%	-11.1%	-19.6%	-30.8%
	6%	13.9%	12.7%	11.3%	9.4%	7.1%	4.2%	0.4%	-4.5%	-10.9%	-19.2%
	7%	14.7%	13.8%	12.6%	11.2%	9.4%	7.1%	4.2%	0.4%	-4.4%	-10.7%
	8%	15.5%	14.7%	13.8%	12.6%	11.2%	9.4%	7.1%	4.2%	0.5%	-4.3%
	9%	16.0%	15.4%	14.6%	13.7%	12.6%	11.1%	9.3%	7.1%	4.2%	0.5%
	10%	16.5%	16.0%	15.4%	14.6%	13.7%	12.5%	11.1%	9.3%	7.0%	4.2%

Data from: Table 13 & Table 14

Table 16: Difference between Two Policies for Woman in Salaried Positions (R=55)

		i									
		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
g	1%	-3.3%	-7.3%	-12.3%	-18.8%	-26.9%	-37.4%	-50.8%	-68.1%	-90.4%	-119.1%
	2%	-0.2%	-3.3%	-7.3%	-12.2%	-18.5%	-26.6%	-36.8%	-50.0%	-66.8%	-88.4%
	3%	2.3%	-0.2%	-3.3%	-7.2%	-12.1%	-18.3%	-26.2%	-36.3%	-49.1%	-65.5%
	4%	4.2%	2.2%	-0.2%	-3.3%	-7.2%	-12.0%	-18.1%	-25.9%	-35.7%	-48.3%
	5%	5.8%	4.2%	2.2%	-0.3%	-3.3%	-7.1%	-11.9%	-17.9%	-25.6%	-35.2%
	6%	7.1%	5.7%	4.1%	2.2%	-0.3%	-3.3%	-7.1%	-11.8%	-17.8%	-25.2%
	7%	8.1%	7.0%	5.7%	4.1%	2.1%	-0.3%	-3.3%	-7.1%	-11.7%	-17.6%
	8%	9.0%	8.0%	7.0%	5.6%	4.0%	2.1%	-0.3%	-3.3%	-7.0%	-11.6%
	9%	9.7%	8.9%	8.0%	6.9%	5.6%	4.0%	2.0%	-0.4%	-3.3%	-7.0%
	10%	10.3%	9.6%	8.8%	7.9%	6.8%	5.5%	3.9%	2.0%	-0.4%	-3.3%

Data from: Appendix 3

Table 17: Difference between Two Policies for Woman in Blue- collar Jobs (R=50)

		i									
		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
g	1%	-7.8%	-11.1%	-15.2%	-20.1%	-26.2%	-33.7%	-43.0%	-54.5%	-68.7%	-86.3%
	2%	-5.2%	-7.8%	-11.1%	-15.1%	-20.0%	-26.0%	-33.3%	-42.4%	-53.6%	-67.5%
	3%	-3.0%	-5.2%	-7.8%	-11.1%	-15.0%	-19.8%	-25.7%	-32.9%	-41.8%	-52.8%
	4%	-1.2%	-3.0%	-5.2%	-7.8%	-11.0%	-14.9%	-19.7%	-25.5%	-32.5%	-41.3%
	5%	0.3%	-1.2%	-3.1%	-5.2%	-7.8%	-11.0%	-14.8%	-19.5%	-25.2%	-32.2%
	6%	1.5%	0.2%	-1.3%	-3.1%	-5.2%	-7.8%	-11.0%	-14.8%	-19.4%	-25.0%
	7%	2.5%	1.4%	0.2%	-1.3%	-3.1%	-5.3%	-7.8%	-10.9%	-14.7%	-19.2%
	8%	3.3%	2.4%	1.4%	0.1%	-1.4%	-3.2%	-5.3%	-7.8%	-10.9%	-14.6%
	9%	4.1%	3.3%	2.4%	1.3%	0.1%	-1.4%	-3.2%	-5.3%	-7.8%	-10.9%
	10%	4.7%	4.0%	3.2%	2.3%	1.3%	0.0%	-1.5%	-3.2%	-5.3%	-7.8%

Data from: Appendix 4

From Table 16&17, which are analogous to Table 15 and present the differences in replacement rates due to policy change, we can conclude that for female retirees, especially those in blue-collar jobs, the new policy will be better off if and only if $i << g$. However, when interest rate is much lower than the wage growth rate, the replacement rate will be at a very low lever (See Table 18). The Replacement rate under the new policy will be under 50% if $i << g$. It can not ensure that the retirees will have a suitable life after retirement, and will lead to insufficiency.

Table 18: Replacement Rates under 2005 Policy when i << g, for Woman in Blue- collar Jobs (R=50)

		i				
		1%	2%	3%	4%	5%
g	5%	39.7%	40.9%	42.4%	44.1%	46.3%
	6%	38.7%	39.7%	41.0%	42.4%	44.2%
	7%	37.9%	38.8%	39.8%	41.0%	42.4%
	8%	37.2%	37.9%	38.8%	39.8%	41.0%
	9%	36.6%	37.3%	38.0%	38.9%	39.9%
	10%	36.1%	36.7%	37.3%	38.0%	38.9%

Data from: Appendix 4

Based on the above discussion, it can be concluded that:

If $i >> g$ the new policy is not an improvement for all the retirees;

If $i \approx g$, men will benefit from the transition, but women will suffer reduction of pension, as discussed in Section 5.1.1;

If $i << g$, all the retirees will be better off, but the pension is probably not sufficient for retirees.

Therefore, the difference between i and g is not the crucial factor that affects the policy transition influence. If we want all the retirees to benefit from the policy transition, we should find the suitable solutions to make $\rho_R{}^2 > \rho_R{}^1$ no matter which relationship is between i and g.

Since $s(a,t)$ is the probability that the worker has a job and contributes to the pension system at age t, in general, it is hard to be influenced by the policy. Therefore, the possible solutions should be the adjustments to the policy fixed parameters.

5.2 Results under Non-continuous Employment

As discussed in the beginning of Sec. 5.1, if under continuous employment, $\rho_R{}^2 < \rho_R{}^1$, it is sure that under non-continuous employment, $\rho_R{}^2$ is also less than $\rho_R{}^1$. It is obvious that, if under non-continuous employment $\rho_R{}^2 > \rho_R{}^1$, it is sure that under continuous employment, $\rho_R{}^2$ is also greater than $\rho_R{}^1$. Therefore, when discussing the solutions to make all the retirees benefit from the policy transition, we can just study the model under non-continuous employment.

There is four policy fixed parameters, the retirement age R, the accumulation rate of individual pension account φ, the initial working age a, and the actuarial factor G_R.

G_R is calculated from life expectancy, and a is from Chinese census data. The last two parameters can't be adjusted by policy, so the replacement rate can be increased only by postponing retirement age or raising the accumulation rate.

From Section 5.1.2, it is obvious that the difference between i and g is not the crucial factor that affects the policy transition influence. It is reasonable to set they are equal in the current section. Besides, if I consider $i \neq g$ in non-continuous employment, this would complicate matters beyond the scope of the thesis.

Under $i = g$, Eq. (5) for replacement rates under 1997 policy will be:

$$\rho_R{}^1 = 0.2 + 0.1\varphi^1 \sum_{t=a}^{R-1} s(a,t) \tag{13}$$

Eq. (6) for replacement rates under 2005 policy will be:

$$\rho_R{}^2 = (R - a - U_R) * 0.01 + \varphi^2 / G_R \sum_{t=a}^{R-1} s(a,t) \tag{14}$$

Assumption B1.2: This retiree has a non-continuous employment before retirement; i.e. $s(a,t)$ = 0 at some years (viz. the number of unemployment years before retirement $U_R \neq 0$).

Then Eq. (13) for 1997's will be:

$$\rho_R^{\,1} = 0.2 + 0.1\varphi^1(R - a - U_R) \tag{15}$$

Eq. (14) for 2005's will be:

$$\rho_R^{\,2} = (0.01 + \varphi^2 / G_R)(R - a - U_R) \tag{16}$$

Now we can set $L_R = R - a - U_R$; L_R as the working life length (in years) for retirees.

S.t. 15< L_R< $R - a$; according to the policy items.

It follows,

$$\rho_R^{\,1} = 0.2 + 0.1\varphi^1 L_R \tag{17}$$

$$\rho_R^{\,2} = (0.01 + \varphi^2 / G_R)L_R \tag{18}$$

5.2.1 Retirement Age and Working Life Length while $\rho_R^{\,2} \geq \rho_R^{\,1}$

When keeping the accumulation rate of individual pension account φ fixed (φ for 1997's is 11%; for 2005's is 8%), the retirement age is the only factor that causes the gender difference in effects of the policy transition.

If we need $\rho_R^{\,2} \geq \rho_R^{\,1}$ to give retirees at least equal well-being after policy transition, the suitable working life length and retirement age is as shown in Table 19.

According to Eq. (17) & (18), when φ is fixed, the replacement rate under 1997 policy is only dependent on the working life length L_R. However, the replacement rate under 2005 policy is also influenced by G_R.

The last column of Table 19 is the replacement rate under 1997 policy corresponding to different working life length.

And in 2005 policy, different retirement ages have different G_R. Therefore, if two retirees retire in different age, although they have equal working life length, their replacement rates will not be same.

Table 19: Replacement Rates under Non-continuous Employment

		2005 Policy (Retirement Age)											1997
		50	51	52	53	54	55	56	57	58	59	60	Policy
L	15	22.4%	22.6%	22.8%	23.0%	23.2%	23.5%	23.8%	24.1%	24.5%	24.9%	25.4%	36.5%
	16	23.9%	24.1%	24.3%	24.5%	24.8%	25.0%	25.4%	25.7%	26.1%	26.6%	27.1%	37.6%
	17	25.4%	25.6%	25.8%	26.1%	26.3%	26.6%	26.9%	27.3%	27.7%	28.3%	28.7%	38.7%
	18	26.9%	27.1%	27.3%	27.6%	27.9%	28.2%	28.5%	28.9%	29.4%	29.9%	30.4%	39.8%
	19	28.4%	28.6%	28.9%	29.1%	29.4%	29.7%	30.1%	30.5%	31.0%	31.6%	32.1%	40.9%
	20	29.8%	30.1%	30.4%	30.7%	31.0%	31.3%	31.7%	32.1%	32.6%	33.2%	33.8%	42.0%
	21	31.3%	31.6%	31.9%	32.2%	32.5%	32.9%	33.3%	33.8%	34.3%	34.9%	35.5%	43.1%
	22	32.8%	33.1%	33.4%	33.7%	34.1%	34.4%	34.9%	35.4%	35.9%	36.6%	37.2%	44.2%
	23	34.3%	34.6%	34.9%	35.3%	35.6%	36.0%	36.5%	37.0%	37.5%	38.2%	38.9%	45.3%
	24	35.8%	36.1%	36.5%	36.8%	37.2%	37.5%	38.0%	38.6%	39.2%	39.9%	40.6%	46.4%
	25	37.3%	37.6%	38.0%	38.3%	38.7%	39.1%	39.6%	40.2%	40.8%	41.6%	42.3%	47.5%
	26	38.8%	39.1%	39.5%	39.9%	40.3%	40.7%	41.2%	41.8%	42.4%	43.2%	44.0%	48.6%
	27	40.3%	40.6%	41.0%	41.4%	41.8%	42.2%	42.8%	43.4%	44.0%	44.9%	45.7%	49.7%
	28	41.8%	42.2%	42.5%	42.9%	43.4%	43.8%	44.4%	45.0%	45.7%	46.5%	47.3%	50.8%
	29	43.3%	43.7%	44.0%	44.5%	44.9%	45.4%	46.0%	46.6%	47.3%	48.2%	49.0%	51.9%
	30	44.8%	45.2%	45.6%	46.0%	46.5%	46.9%	47.6%	48.2%	48.9%	49.9%	50.7%	53.0%
	31	46.3%	46.7%	47.1%	47.5%	48.0%	48.5%	49.1%	49.8%	50.6%	51.5%	52.4%	54.1%
	32	NA	48.2%	48.6%	49.1%	49.6%	50.1%	50.7%	51.4%	52.2%	53.2%	54.1%	55.2%
	33	NA	NA	50.1%	50.6%	51.1%	51.6%	52.3%	53.0%	53.8%	54.9%	55.8%	56.3%
	34	NA	NA	NA	52.1%	52.7%	53.2%	53.9%	54.7%	55.5%	56.5%	57.5%	57.4%
	35	NA	NA	NA	NA	54.2%	54.8%	55.5%	56.3%	57.1%	58.2%	59.2%	58.5%
	36	NA	NA	NA	NA	NA	56.3%	57.1%	57.9%	58.7%	59.8%	60.9%	59.6%
	37	NA	NA	NA	NA	NA	NA	58.7%	59.5%	60.4%	61.5%	62.6%	60.7%
	38	NA	NA	NA	NA	NA	NA	NA	61.1%	62.0%	63.2%	64.3%	61.8%
	39	NA	NA	NA	NA	NA	NA	NA	NA	63.6%	64.8%	65.9%	62.9%
	40	NA	NA	NA	NA	NA	NA	NA	NA	NA	66.5%	67.6%	64.0%
	41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	69.3%	65.1%

There are a few cases in Table 19 when the replacement rate under 2005's will be higher than that under 1997's. They are:

1) Retirement age R = 58; if working life length $L_R \geq 38$;
2) Retirement age R = 59; if working life length $L_R \geq 36$
3) Retirement age R = 60; if working life length $L_R \geq 34$

Hereby under the statutory retirement ages (50 or 55), women can not be better off. Retirement should be postponed to raise the replacement rate of women.

Since $s(a,t)$ is hard to be influenced by the policy, the working life length can not be affected either. However, we can give a possible solution, under which the replacement rate under 2005's can be higher than that under 1997's. In other words, for example, if the worker retires at age 60, he/she will benefit from policy transition as long as he/she has worked long enough ($L_R \geq 34$). But if the worker retires at age 55, he/she can not benefit from policy transition under any condition.

In conclusion, when keeping φ fixed, the retirement age of women should deter to at least 58 (Both Women in Salaried positions and in blue-collar jobs) to give female retirees at least the same quality of life after policy transition.

5.2.2 Higher Accumulation Rates

As it follows from the description in Ch. 3, another reason which leads to insufficiency under 2005 policy is accumulation rate decrease in individual account. φ^2 in 2005 policy is 8%, while φ^1 in 1997's is 11%.

If φ^2 can be varied with different types of workers (men, women in salaried positions, and women in blue-collar jobs), the replacement rates can be equalized between two policies.

$$\rho_R{}^2 = \rho_R{}^1$$

From Equation (17) & (18): $(0.01+\varphi^2/G_R)L_R = 0.2+0.1\varphi^1 L_R$

Inset $\varphi^1 = 11\%$ according to 1997 policy into the above equation, it follows,

$$\varphi^2 = \frac{0.2+0.001L_R}{L_R} G_R \qquad (19)$$

Table 20 shows the suitable φ^2 when the replacement rates are equal in the two policies.

Table 20: φ^2 under Equal Replacement Rates

φ^2		R & G		
		50	55	60
		16.25	14.17	11.58
L	15	23.3%	20.3%	16.6%
	16	21.9%	19.1%	15.6%
	17	20.7%	18.1%	14.8%
	18	19.7%	17.2%	14.0%
	19	18.7%	16.3%	13.3%
	20	17.9%	15.6%	12.7%
	21	17.1%	14.9%	12.2%
	22	16.4%	14.3%	11.7%
	23	15.8%	13.7%	11.2%
	24	15.2%	13.2%	10.8%
	25	14.6%	12.8%	10.4%
	26	14.1%	12.3%	10.1%
	27	13.7%	11.9%	9.7%
	28	13.2%	11.5%	9.4%
	29	12.8%	11.2%	9.1%
	30	12.5%	10.9%	8.9%
	31	12.1%	10.6%	8.6%
	32	NA	10.3%	8.4%
	33	NA	10.0%	8.2%
	34	NA	9.8%	8.0%
	35	NA	9.5%	7.8%
	36	NA	9.3%	7.6%
	37	NA	NA	7.4%
	38	NA	NA	7.3%
	39	NA	NA	7.1%
	40	NA	NA	6.9%
	41	NA	NA	6.8%

1) For women in blue-collar jobs: $\rho_R{}^2$ can be equal to or greater than $\rho_R{}^1$ if $\varphi^2 \geq 12.1\%$
2) For women in salaried positions: $\rho_R{}^2$ can be equal to or greater than $\rho_R{}^1$ if $\varphi^2 \geq 9.3\%$
3) For men: $\rho_R{}^2$ can be equal to or greater than $\rho_R{}^1$ if $\varphi^2 \geq 6.8\%$

Therefore, we can set different φ^2 in 2005 policy in order that all the retirees can live at least of the same quality as under 1997 policy.

5.2.3 The Combination of Higher Retirement Age and Accumulation Rates

If we only postpone the retirement ages to ensure women equal pensions, the retirement age for women in blue-collar jobs should change from 50 to 58. Similarly, if we only raise the accumulation rate in individual accounts, it should raise from 8% to 12% for women in blue-collar jobs.

However we can think about a combination of these two methods, which is raising the two together to more appropriate levels. First of all, for policy design, the retirement age and accumulation rate are better to be integers. Thus it is reasonable to find suitable R for φ^2 from 9% to 11% (See Table 21 to 23).

Table 21: Replacement Rates under φ^2 =9%

		2005 Policy, the accumulative rate of individual pension account is 9%											1997
		50	51	52	53	54	55	56	57	58	59	60	Policy
L	15	23.3%	23.5%	23.8%	24.0%	24.3%	24.5%	24.9%	25.3%	25.7%	26.2%	26.7%	36.5%
	16	24.9%	25.1%	25.3%	25.6%	25.9%	26.2%	26.5%	26.9%	27.4%	27.9%	28.4%	37.6%
	17	26.4%	26.7%	26.9%	27.2%	27.5%	27.8%	28.2%	28.6%	29.1%	29.7%	30.2%	38.7%
	18	28.0%	28.2%	28.5%	28.8%	29.1%	29.4%	29.9%	30.3%	30.8%	31.4%	32.0%	39.8%
	19	29.5%	29.8%	30.1%	30.4%	30.7%	31.1%	31.5%	32.0%	32.5%	33.2%	33.8%	40.9%
	20	31.1%	31.4%	31.7%	32.0%	32.3%	32.7%	33.2%	33.7%	34.2%	34.9%	35.5%	42.0%
	21	32.6%	32.9%	33.3%	33.6%	34.0%	34.3%	34.8%	35.4%	35.9%	36.6%	37.3%	43.1%
	22	34.2%	34.5%	34.8%	35.2%	35.6%	36.0%	36.5%	37.0%	37.6%	38.4%	39.1%	44.2%
	23	35.7%	36.1%	36.4%	36.8%	37.2%	37.6%	38.1%	38.7%	39.3%	40.1%	40.9%	45.3%
	24	37.3%	37.6%	38.0%	38.4%	38.8%	39.2%	39.8%	40.4%	41.0%	41.9%	42.7%	46.4%
	25	38.8%	39.2%	39.6%	40.0%	40.4%	40.9%	41.5%	42.1%	42.8%	43.6%	44.4%	47.5%
	26	40.4%	40.8%	41.2%	41.6%	42.0%	42.5%	43.1%	43.8%	44.5%	45.4%	46.2%	48.6%
	27	42.0%	42.4%	42.8%	43.2%	43.7%	44.1%	44.8%	45.5%	46.2%	47.1%	48.0%	49.7%
	28	43.5%	43.9%	44.3%	44.8%	45.3%	45.8%	46.4%	47.1%	47.9%	48.9%	49.8%	50.8%
	29	45.1%	45.5%	45.9%	46.4%	46.9%	47.4%	48.1%	48.8%	49.6%	50.6%	51.5%	51.9%
	30	46.6%	47.1%	47.5%	48.0%	48.5%	49.1%	49.8%	50.5%	51.3%	52.4%	53.3%	53.0%
	31	48.2%	48.6%	49.1%	49.6%	50.1%	50.7%	51.4%	52.2%	53.0%	54.1%	55.1%	54.1%
	32	NA	50.2%	50.7%	51.2%	51.8%	52.3%	53.1%	53.9%	54.7%	55.8%	56.9%	55.2%
	33	NA	NA	52.3%	52.8%	53.4%	54.0%	54.7%	55.6%	56.4%	57.6%	58.6%	56.3%
	34	NA	NA	NA	54.4%	55.0%	55.6%	56.4%	57.2%	58.2%	59.3%	60.4%	57.4%
	35	NA	NA	NA	NA	56.6%	57.2%	58.0%	58.9%	59.9%	61.1%	62.2%	58.5%
	36	NA	NA	NA	NA	NA	58.9%	59.7%	60.6%	61.6%	62.8%	64.0%	59.6%
	37	NA	NA	NA	NA	NA	NA	61.4%	62.3%	63.3%	64.6%	65.8%	60.7%
	38	NA	NA	NA	NA	NA	NA	NA	64.0%	65.0%	66.3%	67.5%	61.8%
	39	NA	NA	NA	NA	NA	NA	NA	NA	66.7%	68.1%	69.3%	62.9%
	40	NA	NA	NA	NA	NA	NA	NA	NA	NA	69.8%	71.1%	64.0%
	41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	72.9%	65.1%

Table 22: Replacement Rates under φ^2=10%

		2005 Policy, the accumulative rate of individual pension account is 10%											1997
		50	51	52	53	54	55	56	57	58	59	60	Policy
L	15	24.2%	24.5%	24.7%	25.0%	25.3%	25.6%	26.0%	26.4%	26.8%	27.4%	28.0%	36.5%
	16	25.8%	26.1%	26.4%	26.7%	27.0%	27.3%	27.7%	28.1%	28.6%	29.2%	29.8%	37.6%
	17	27.5%	27.7%	28.0%	28.3%	28.7%	29.0%	29.4%	29.9%	30.4%	31.1%	31.7%	38.7%
	18	29.1%	29.4%	29.7%	30.0%	30.3%	30.7%	31.2%	31.7%	32.2%	32.9%	33.5%	39.8%
	19	30.7%	31.0%	31.3%	31.7%	32.0%	32.4%	32.9%	33.4%	34.0%	34.7%	35.4%	40.9%
	20	32.3%	32.6%	33.0%	33.3%	33.7%	34.1%	34.6%	35.2%	35.8%	36.6%	37.3%	42.0%
	21	33.9%	34.3%	34.6%	35.0%	35.4%	35.8%	36.4%	36.9%	37.6%	38.4%	39.1%	43.1%
	22	35.5%	35.9%	36.3%	36.7%	37.1%	37.5%	38.1%	38.7%	39.4%	40.2%	41.0%	44.2%
	23	37.2%	37.5%	37.9%	38.3%	38.8%	39.2%	39.8%	40.5%	41.2%	42.0%	42.9%	45.3%
	24	38.8%	39.2%	39.6%	40.0%	40.5%	40.9%	41.6%	42.2%	42.9%	43.9%	44.7%	46.4%
	25	40.4%	40.8%	41.2%	41.7%	42.1%	42.6%	43.3%	44.0%	44.7%	45.7%	46.6%	47.5%
	26	42.0%	42.4%	42.9%	43.3%	43.8%	44.3%	45.0%	45.7%	46.5%	47.5%	48.5%	48.6%
	27	43.6%	44.1%	44.5%	45.0%	45.5%	46.1%	46.8%	47.5%	48.3%	49.4%	50.3%	49.7%
	28	45.2%	45.7%	46.2%	46.7%	47.2%	47.8%	48.5%	49.3%	50.1%	51.2%	52.2%	50.8%
	29	46.8%	47.3%	47.8%	48.3%	48.9%	49.5%	50.2%	51.0%	51.9%	53.0%	54.0%	51.9%
	30	48.5%	49.0%	49.5%	50.0%	50.6%	51.2%	51.9%	52.8%	53.7%	54.8%	55.9%	53.0%
	31	50.1%	50.6%	51.1%	51.7%	52.3%	52.9%	53.7%	54.5%	55.5%	56.7%	57.8%	54.1%
	32	NA	52.2%	52.8%	53.3%	53.9%	54.6%	55.4%	56.3%	57.3%	58.5%	59.6%	55.2%
	33	NA	NA	54.4%	55.0%	55.6%	56.3%	57.1%	58.1%	59.0%	60.3%	61.5%	56.3%
	34	NA	NA	NA	56.7%	57.3%	58.0%	58.9%	59.8%	60.8%	62.1%	63.4%	57.4%
	35	NA	NA	NA	NA	59.0%	59.7%	60.6%	61.6%	62.6%	64.0%	65.2%	58.5%
	36	NA	NA	NA	NA	NA	61.4%	62.3%	63.3%	64.4%	65.8%	67.1%	59.6%
	37	NA	NA	NA	NA	NA	NA	64.1%	65.1%	66.2%	67.6%	69.0%	60.7%
	38	NA	NA	NA	NA	NA	NA	NA	66.9%	68.0%	69.5%	70.8%	61.8%
	39	NA	NA	NA	NA	NA	NA	NA	NA	69.8%	71.3%	72.7%	62.9%
	40	NA	NA	NA	NA	NA	NA	NA	NA	NA	73.1%	74.5%	64.0%
	41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	76.4%	65.1%

Table 23: Replacement Rates under φ^2=11%

		2005 Policy, the accumulative rate of individual pension account is 11%											1997
		50	51	52	53	54	55	56	57	58	59	60	Policy
L	15	25.2%	25.4%	25.7%	26.0%	26.3%	26.6%	27.1%	27.5%	28.0%	28.7%	29.2%	36.5%
	16	26.8%	27.1%	27.4%	27.7%	28.1%	28.4%	28.9%	29.4%	29.9%	30.6%	31.2%	37.6%
	17	28.5%	28.8%	29.1%	29.5%	29.8%	30.2%	30.7%	31.2%	31.8%	32.5%	33.1%	38.7%
	18	30.2%	30.5%	30.8%	31.2%	31.6%	32.0%	32.5%	33.0%	33.6%	34.4%	35.1%	39.8%
	19	31.9%	32.2%	32.6%	32.9%	33.3%	33.7%	34.3%	34.9%	35.5%	36.3%	37.0%	40.9%
	20	33.5%	33.9%	34.3%	34.7%	35.1%	35.5%	36.1%	36.7%	37.4%	38.2%	39.0%	42.0%
	21	35.2%	35.6%	36.0%	36.4%	36.8%	37.3%	37.9%	38.5%	39.2%	40.1%	40.9%	43.1%
	22	36.9%	37.3%	37.7%	38.1%	38.6%	39.1%	39.7%	40.4%	41.1%	42.0%	42.9%	44.2%
	23	38.6%	39.0%	39.4%	39.9%	40.4%	40.9%	41.5%	42.2%	43.0%	43.9%	44.8%	45.3%
	24	40.2%	40.7%	41.1%	41.6%	42.1%	42.6%	43.3%	44.0%	44.8%	45.9%	46.8%	46.4%
	25	41.9%	42.4%	42.8%	43.3%	43.9%	44.4%	45.1%	45.9%	46.7%	47.8%	48.7%	47.5%
	26	43.6%	44.1%	44.5%	45.1%	45.6%	46.2%	46.9%	47.7%	48.6%	49.7%	50.7%	48.6%
	27	45.3%	45.8%	46.3%	46.8%	47.4%	48.0%	48.7%	49.6%	50.4%	51.6%	52.6%	49.7%
	28	47.0%	47.5%	48.0%	48.5%	49.1%	49.7%	50.5%	51.4%	52.3%	53.5%	54.6%	50.8%
	29	48.6%	49.2%	49.7%	50.3%	50.9%	51.5%	52.3%	53.2%	54.2%	55.4%	56.5%	51.9%
	30	50.3%	50.8%	51.4%	52.0%	52.6%	53.3%	54.1%	55.1%	56.0%	57.3%	58.5%	53.0%
	31	52.0%	52.5%	53.1%	53.7%	54.4%	55.1%	55.9%	56.9%	57.9%	59.2%	60.4%	54.1%
	32	NA	54.2%	54.8%	55.5%	56.1%	56.8%	57.7%	58.7%	59.8%	61.1%	62.4%	55.2%
	33	NA	NA	56.5%	57.2%	57.9%	58.6%	59.6%	60.6%	61.7%	63.0%	64.3%	56.3%
	34	NA	NA	NA	58.9%	59.7%	60.4%	61.4%	62.4%	63.5%	65.0%	66.3%	57.4%
	35	NA	NA	NA	NA	61.4%	62.2%	63.2%	64.2%	65.4%	66.9%	68.2%	58.5%
	36	NA	NA	NA	NA	NA	63.9%	65.0%	66.1%	67.3%	68.8%	70.2%	59.6%
	37	NA	NA	NA	NA	NA	NA	66.8%	67.9%	69.1%	70.7%	72.1%	60.7%
	38	NA	NA	NA	NA	NA	NA	NA	69.7%	71.0%	72.6%	74.1%	61.8%
	39	NA	NA	NA	NA	NA	NA	NA	NA	72.9%	74.5%	76.0%	62.9%
	40	NA	NA	NA	NA	NA	NA	NA	NA	NA	76.4%	78.0%	64.0%
	41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	79.9%	65.1%

In a word, we can find the lowest R for each φ^2 as follows, which can be use to draw a joint policy adjustment.

1) R= 58 when φ^2 =8%;
2) R= 56 when φ^2 =9%;
3) R= 54 when φ^2 =10%;
4) R= 52 when φ^2 =11%;
5) R= 51 when φ^2 =12%;
6) R= 50 when φ^2 =13%;

6. Conclusions

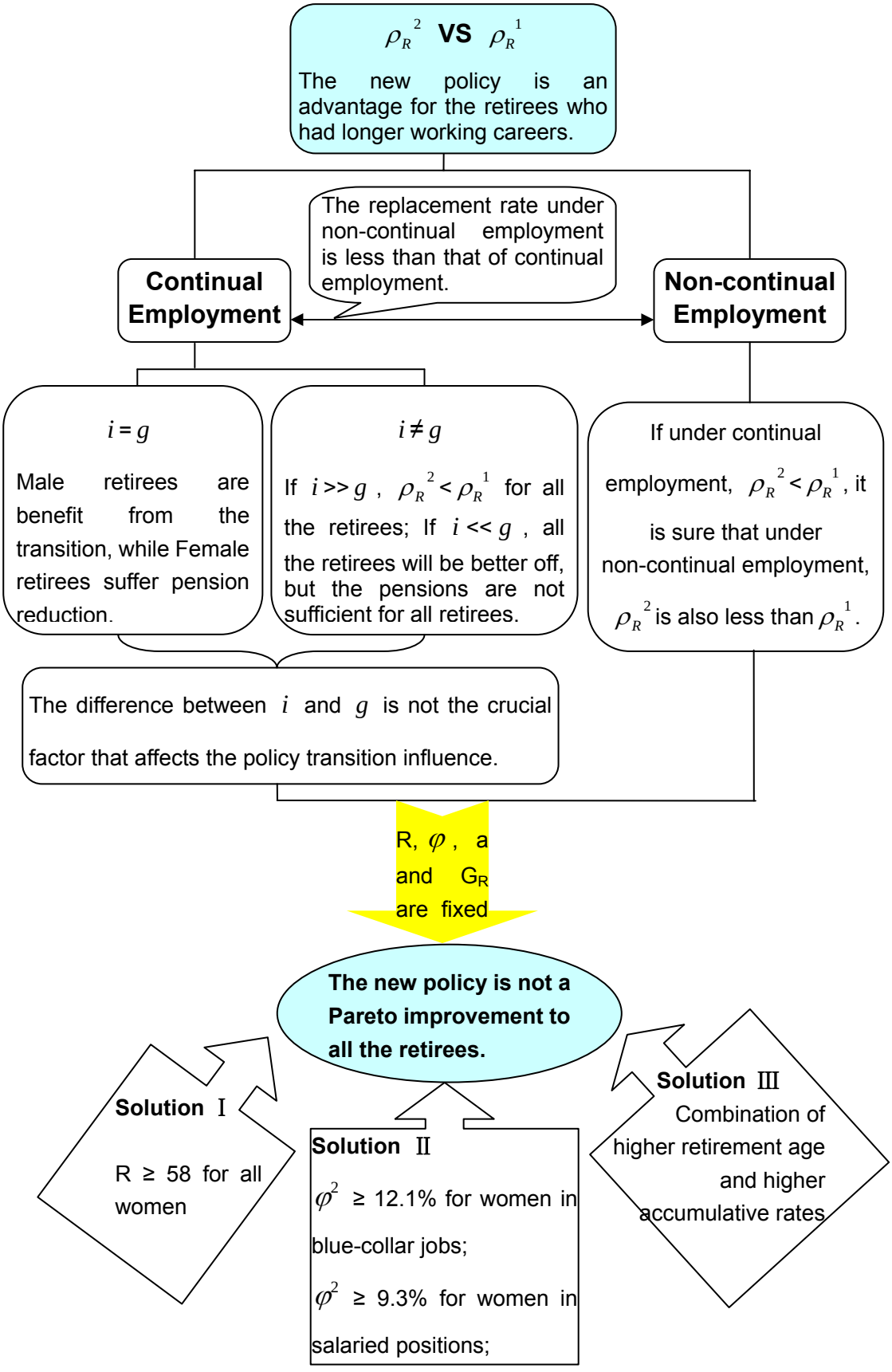
First of all, this paper focuses on the comparison of pension replacement rates between old and new policies in China. Although China's pension system has a lot of other serious issues such as how to finance old age persons in rural China, or how to transit from the old unfunded system to the new arrangements, I believe it is important to discuss the effects of new policy for a single urban retiree.

From the description on how the pension policies have been changed during the last 60 years, it can be concluded that pension reform in China is aimed to change the system from the unfunded one to a long-time effective self-funded pension system. The transition from old policy (1997) to the new one (2005) is mainly because of the short-comings in the individual accounts which should be compensated by both central and local governments, but the effects to individual pension benefits are considered less. However, since the basic pension is the only financial support for most Chinese retirees, and the replacement level under old policy is not superfluous, in general, a new pension policy should give corrected to give the retirees at least equal well-being.

The analysis undertaken for comparing the replacement rates under the two policies in this thesis can be summarized in the following scheme (See Figure 11).

First the comparison is performed under the assumption of continuous employment. Results show that: if $i >> g$ the new policy is not an improvement for all the retirees; if $i \approx g$, male retirees benefit from the transition, while female retirees suffer a pension reduction, especially women working in blue-collar jobs; if $i << g$, all the retirees will be better off, but the pension level is probably not sufficient for all retirees.

Figure 11: Insufficiency under 2005's and Possible Solutions



It is shown in policy comparison that the new policy gives the advantage to retirees who had longer working careers. Thus if under continuous employment, the replacement rates under the new policy are less than those under the old one ($\rho_R^{\,2} < \rho_R^{\,1}$), it is sure that under non-continuous employment, $\rho_R^{\,2}$ is also less than $\rho_R^{\,1}$.

The numerical results indicate that the new policy is not a Pareto improvement when the policy fixed parameters are not adjusted. In most cases, the male retirees benefit from the transition, while female retirees suffer a pension reduction, especially the women working in blue-collar jobs.

Three possible solutions are suggested in this work, which include adjusting the statutory retirement age, raising the contribution rate in individual account or the combination of both as in Figure 11. The explanations in Sec. 2.4 show that now the total contribution rate in China is very high compared to those of other regions, while the statutory retirement age for females in China is lower than most of other Asian countries. Therefore, a suitable plan could be postponing female retirement age step by step while raising accumulation rate in individual pension accounts by 2 or 3 percent points.

There are some challenges which may make the implementation of the suggested remedies. One is the unemployment rate in China which I have mentioned before. In 1978 Amendments, the government once lowed the statutory retirement age to give room for younger workers. Thus if the unemployment rate rises in China, which is reasonable due to the current financial crises, the statutory female retirement age will hardly be raised. Another challenge is aging problem, it can lower the unemployment rate in a certain extent; however, it will cause more expenditures and fewer contributions in the social pool of the pension system. This means short-comings will occur in individual accounts again, which will lead to the government rethinking of the 2005 policy and probably cause it to set an even lower accumulation rate in individual pension accounts in order to raise that of the social pool.

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Appendix

Appendix 1

Table A1: Dependency Ratio and Coverage (1989-2007)

Year	Contributors (10,000 persons)	Recipients (10,000 persons)	Dependency Ratio	Urban Employees (10,000 persons)	Coverage (% of urban employees)
1989	4816.9	893.4	5.39	14390	39.7%
1990	5200.7	965.3	5.39	17041	36.2%
1991	5653.7	1086.6	5.20	17465	38.6%
1992	7774.7	1681.5	4.62	17861	52.9%
1993	8008.2	1839.4	4.35	18262	53.9%
1994	8494.1	2079.4	4.08	18653	56.7%
1995	8737.8	2241.2	3.90	19040	57.7%
1996	8758.4	2358.3	3.71	19922	55.8%
1997	8670.9	2533.0	3.42	20781	53.9%
1998	8475.8	2727.3	3.11	21616	51.8%
1999	9501.8	2983.6	3.18	22412	55.7%
2000	10447.5	3169.9	3.30	23151	58.8%
2001	10801.9	3380.6	3.20	23940	59.2%
2002	11128.8	3607.8	3.08	24780	59.5%
2003	11646.5	3860.2	3.02	25639	60.5%
2004	12250.3	4102.6	2.99	26476	61.8%
2005	13120.4	4367.5	3.00	27331	64.0%
2006	14130.9	4635.4	3.05	28310	66.3%
2007	15183.2	4953.7	3.07	29350	68.6%

Table A2: Growth Rates of Recipients and Contributors (1990-2007)

Year	Growth Rate of Recipients	Growth Rate of Contributors
1990	8.0%	8.0%
1991	12.6%	8.7%
1992	54.8%	37.5%
1993	9.4%	3.0%
1994	13.0%	6.1%
1995	7.8%	2.9%
1996	5.2%	0.2%
1997	7.4%	-1.0%
1998	7.7%	-2.3%
1999	9.4%	12.1%
2000	6.2%	10.0%
2001	6.6%	3.4%
2002	6.7%	3.0%
2003	7.0%	4.7%
2004	6.3%	5.2%
2005	6.5%	7.1%
2006	6.1%	7.7%
2007	6.9%	7.4%

Data from: China Labour Statistical Yearbook 2008.

Appendix 2

Table A3: Contribution Rates and Account and Account Accumulation Rates in 1997 Policy Design

year	Enterprises' Contribution	Employees' Contribution	Total Contribution	Individual Account Accumulation	Social Pool Accumulation
97-98	20%	4%	24%	11%	13%
99-00	20%	5%	25%	11%	14%
01-02	20%	6%	26%	11%	15%
03-04	20%	7%	27%	11%	16%
2005	20%	8%	28%	11%	17%

Data from: "Decision of the State Council on Establishment of Unified Basic Old Age Insurance System for Enterprise Staff and Workers" (1997 Policy),.

Appendix 3

Table A4: Replacement Rates under 1997 Policy when i ≠ g for Woman in Salaried Positions (R=55)

		i									
		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
g	1%	59.6%	67.8%	78.1%	91.2%	108.0%	129.5%	157.0%	192.4%	238.1%	297.0%
	2%	53.2%	59.6%	67.7%	77.9%	90.8%	107.3%	128.3%	155.2%	189.7%	234.1%
	3%	48.1%	53.2%	59.6%	67.6%	77.7%	90.4%	106.6%	127.1%	153.4%	187.1%
	4%	44.1%	48.2%	53.3%	59.6%	67.5%	77.4%	90.0%	105.9%	126.0%	151.7%
	5%	40.9%	44.2%	48.3%	53.3%	59.6%	67.4%	77.2%	89.6%	105.2%	125.0%
	6%	38.3%	41.0%	44.3%	48.4%	53.4%	59.6%	67.3%	77.0%	89.2%	104.5%
	7%	36.2%	38.4%	41.1%	44.4%	48.5%	53.4%	59.6%	67.3%	76.8%	88.8%
	8%	34.4%	36.3%	38.5%	41.2%	44.5%	48.6%	53.5%	59.6%	67.2%	76.6%
	9%	33.0%	34.6%	36.4%	38.7%	41.4%	44.6%	48.6%	53.5%	59.6%	67.1%
	10%	31.8%	33.1%	34.7%	36.5%	38.8%	41.5%	44.7%	48.7%	53.6%	59.6%

Table A5: Replacement Rates under 2005 Policy when i ≠ g for Woman in Salaried Positions (R=55)

		i									
		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
g	1%	56.3%	60.5%	65.8%	72.5%	81.1%	92.1%	106.2%	124.3%	147.7%	177.9%
	2%	53.0%	56.3%	60.4%	65.6%	72.3%	80.7%	91.5%	105.2%	122.9%	145.6%
	3%	50.4%	53.0%	56.3%	60.4%	65.5%	72.1%	80.3%	90.9%	104.3%	121.6%
	4%	48.4%	50.5%	53.0%	56.3%	60.3%	65.4%	71.8%	80.0%	90.3%	103.5%
	5%	46.7%	48.4%	50.5%	53.1%	56.3%	60.3%	65.3%	71.6%	79.6%	89.8%
	6%	45.4%	46.8%	48.5%	50.5%	53.1%	56.3%	60.2%	65.2%	71.4%	79.3%
	7%	44.3%	45.4%	46.8%	48.5%	50.6%	53.1%	56.3%	60.2%	65.1%	71.2%
	8%	43.4%	44.4%	45.5%	46.9%	48.6%	50.6%	53.2%	56.3%	60.2%	65.0%
	9%	42.7%	43.5%	44.4%	45.6%	46.9%	48.6%	50.7%	53.2%	56.3%	60.1%
	10%	42.0%	42.7%	43.5%	44.5%	45.6%	47.0%	48.7%	50.7%	53.2%	56.3%

Appendix 4

Table A6: Replacement Rates under 1997 Policy when i ≠ g for Woman in Blue- collar Jobs (R=50)

		i									
		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
g	1%	54.1%	60.1%	67.4%	76.4%	87.4%	101.0%	117.8%	138.5%	164.2%	196.1%
	2%	49.2%	54.1%	60.0%	67.2%	76.1%	86.9%	100.2%	116.7%	136.9%	162.0%
	3%	45.3%	49.3%	54.1%	59.9%	67.1%	75.8%	86.4%	99.5%	115.6%	135.4%
	4%	42.1%	45.4%	49.3%	54.1%	59.9%	66.9%	75.5%	86.0%	98.8%	114.6%
	5%	39.4%	42.2%	45.4%	49.4%	54.1%	59.8%	66.8%	75.2%	85.5%	98.2%
	6%	37.3%	39.5%	42.3%	45.5%	49.4%	54.1%	59.8%	66.6%	75.0%	85.1%
	7%	35.4%	37.3%	39.6%	42.3%	45.6%	49.4%	54.1%	59.7%	66.5%	74.7%
	8%	33.9%	35.5%	37.4%	39.7%	42.4%	45.6%	49.5%	54.1%	59.7%	66.4%
	9%	32.6%	34.0%	35.6%	37.5%	39.8%	42.5%	45.7%	49.5%	54.1%	59.6%
	10%	31.5%	32.7%	34.1%	35.7%	37.6%	39.9%	42.6%	45.8%	49.6%	54.1%

Table A7: Replacement Rates under 2005 Policy when i ≠ g for Woman in Blue- collar Jobs (R=50)

		i									
		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
g	1%	46.3%	48.9%	52.2%	56.2%	61.2%	67.2%	74.8%	84.0%	95.6%	109.8%
	2%	44.1%	46.3%	48.9%	52.1%	56.1%	60.9%	66.9%	74.3%	83.3%	94.6%
	3%	42.3%	44.1%	46.3%	48.9%	52.1%	56.0%	60.7%	66.6%	73.8%	82.7%
	4%	40.9%	42.4%	44.1%	46.3%	48.9%	52.0%	55.8%	60.5%	66.3%	73.3%
	5%	39.7%	40.9%	42.4%	44.1%	46.3%	48.8%	51.9%	55.7%	60.3%	66.0%
	6%	38.7%	39.7%	41.0%	42.4%	44.2%	46.3%	48.8%	51.9%	55.6%	60.1%
	7%	37.9%	38.8%	39.8%	41.0%	42.4%	44.2%	46.3%	48.8%	51.8%	55.5%
	8%	37.2%	37.9%	38.8%	39.8%	41.0%	42.5%	44.2%	46.3%	48.7%	51.7%
	9%	36.6%	37.3%	38.0%	38.9%	39.9%	41.1%	42.5%	44.2%	46.3%	48.7%
	10%	36.1%	36.7%	37.3%	38.0%	38.9%	39.9%	41.1%	42.5%	44.2%	46.3%